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TASK FORCE DELAY STUDY. DENVER STAPLETON INTERNATIONAL AIRPORT,--ETC(U)
MAR 80 DOT-FA77WA-3961

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LEVEL III

16. Abstract

This report contains supporting documentation for the detailed analysis of the Denver Stapleton International Airport. The analysis was conducted by the Denver Airport Improvement Working Group which had representatives from the City and County of Denver, the Air Transport Association, the airlines serving Denver, and the Federal Aviation Administration. Technical support was provided by Peak, Marwick, Mitchell and Co., and the FAA Technical Center. The purpose of the analysis was to determine the causes of delay and the potential delay reduction benefits of recommended improvements. The effort was part of the Airport Improvement Program.

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Telephone: (415) 347-9521

February 20, 1978

Mr. Philip LaRochelle, AEM-100
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

Dear Phil:

Attached are copies of viewgraphs presented to the Denver Stapleton Task Force concerning the impact of the closure of Runway 8R-26L on aircraft delay. Should you desire additional information, please let me know.

Sincerely,

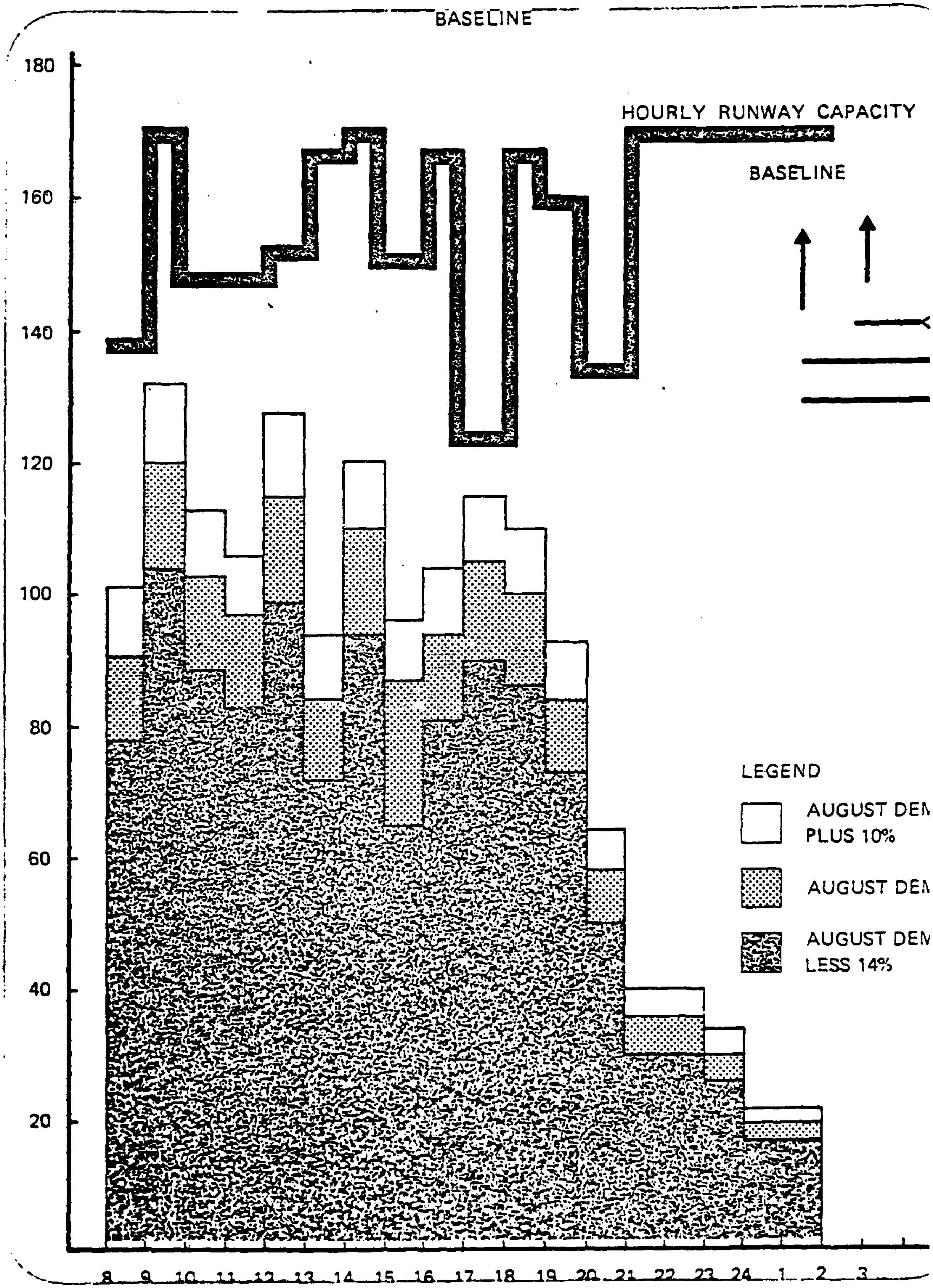
Stephen L. M. Hockaday
Manager

SLMH/jc
Enclosures

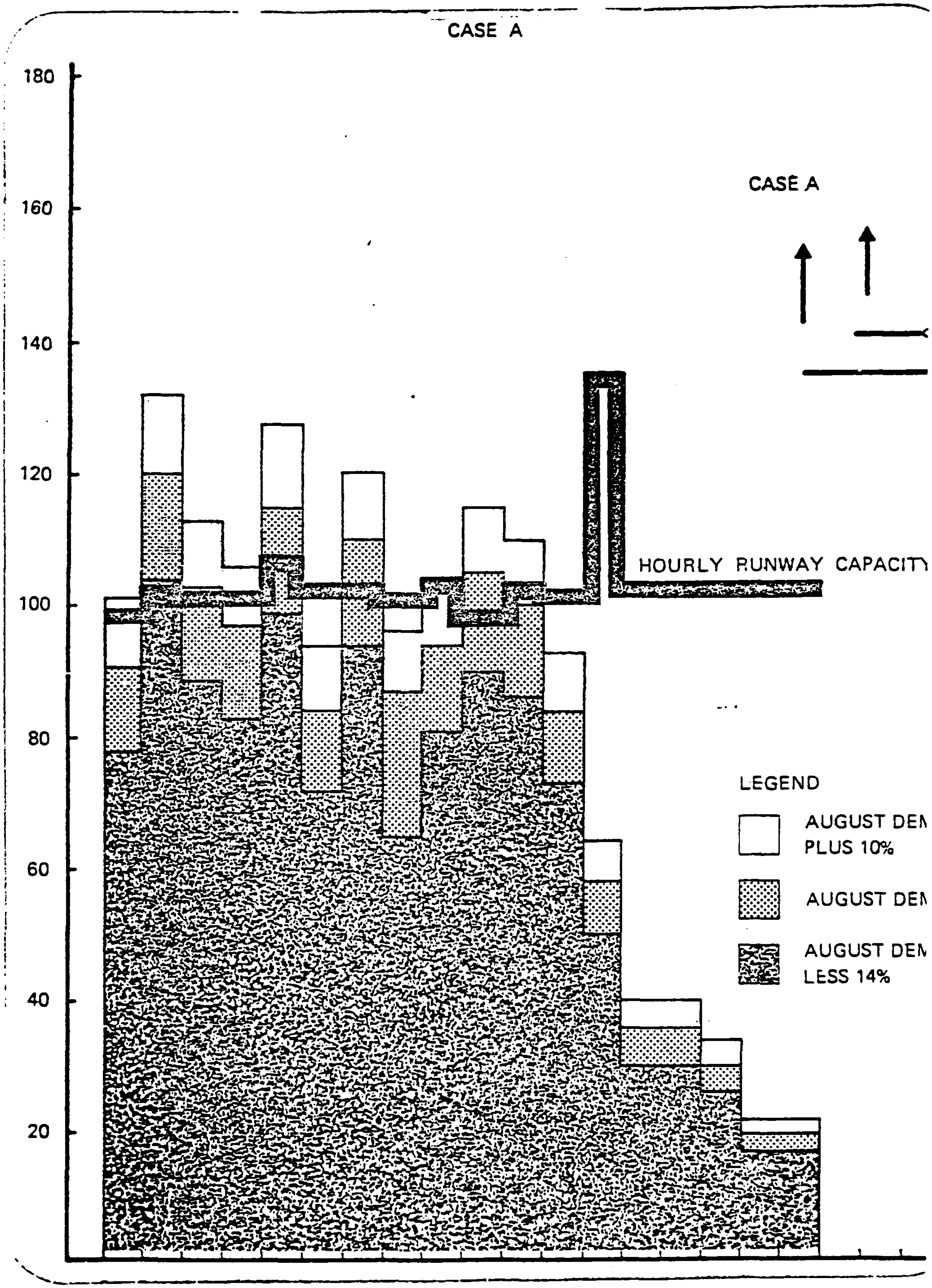
bcc: TFD Correspondence

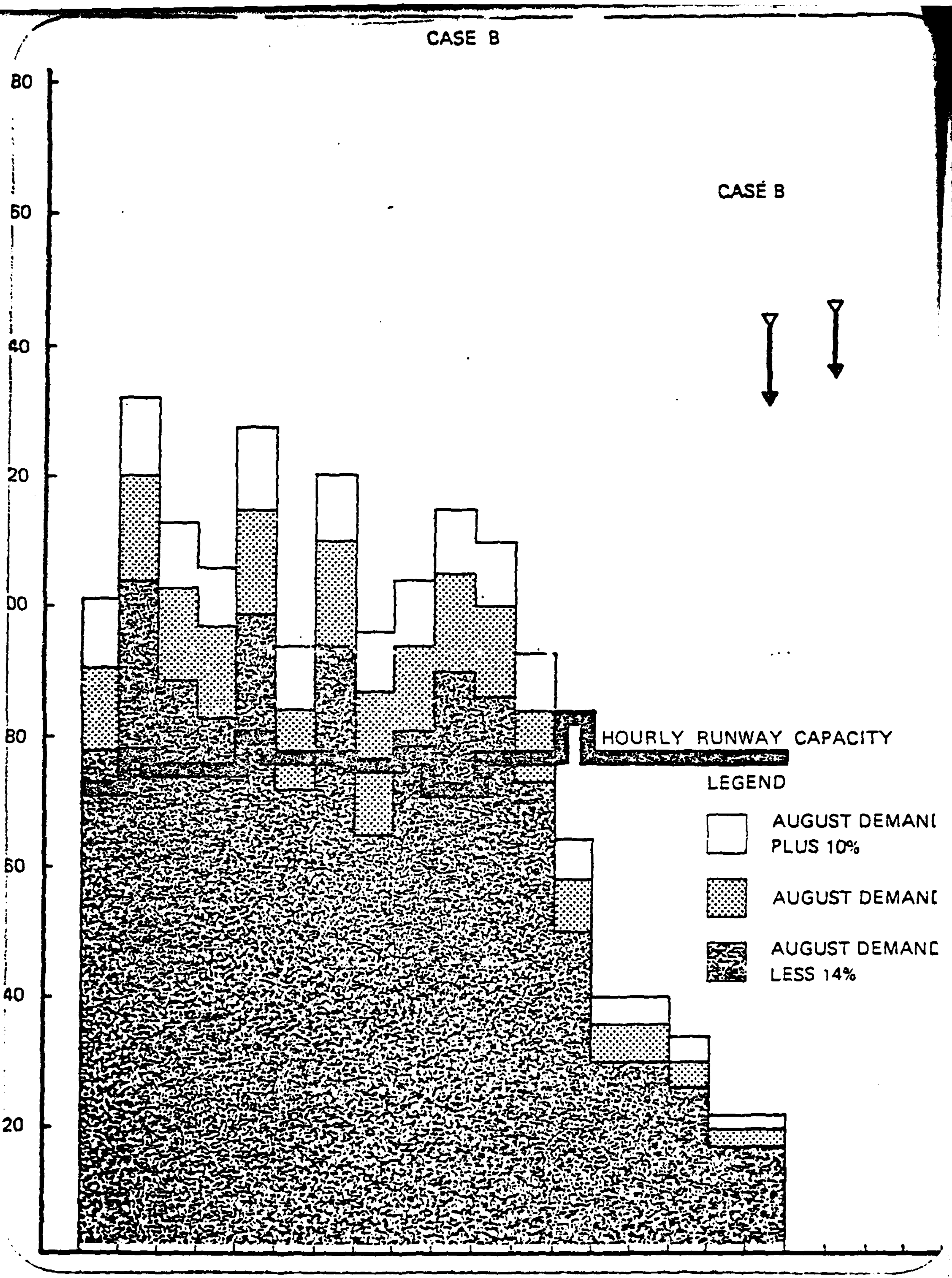
PRELIMINARY DELAY ANALYSIS STEPS

1. ESTABLISH DEMAND IN EACH HOUR
2. ESTABLISH DEMAND PROFILE WITHIN HOUR
3. COMPUTE CAPACITY IN EACH HOUR
4. COMPUTE DELAYS IN EACH HOUR
5. CALCULATE DAILY DELAYS

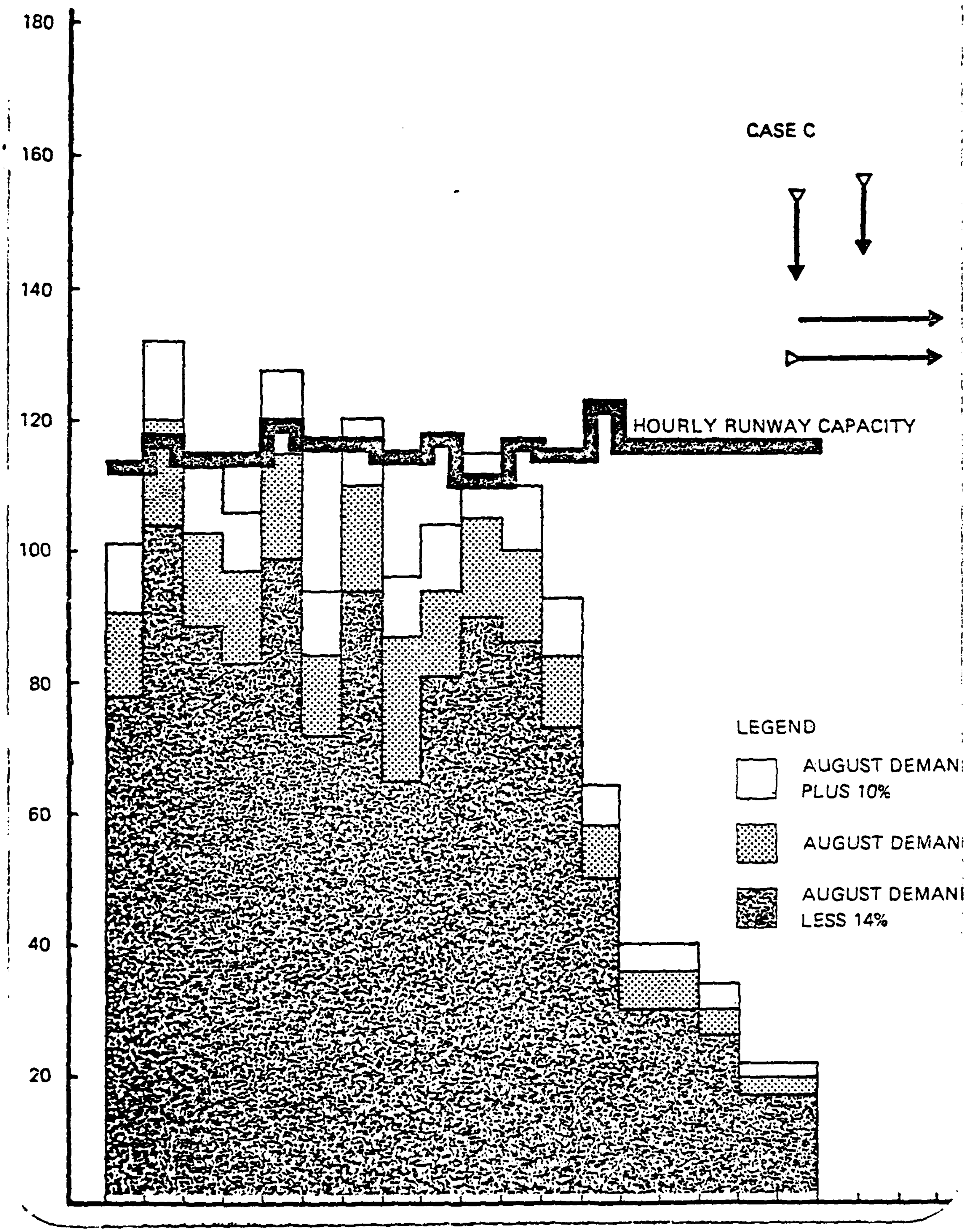


BASELINE
HOURLY RUNWAY CAPACITY
BASELINE
180
160
140
120
100
80
60
40
20
8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 1 2 3
LEGEND
AUGUST DEM
PLUS 10%
AUGUST DEM
AUGUST DEM
LESS 14%


CASE A
180
160
140
120
100
80
60
40
20
CASE A
HOURLY RUNWAY CAPACITY
LEGEND
AUGUST DEM
PLUS 10%
AUGUST DEM
AUGUST DEM
LESS 14%


CASE B
80
60
40
20
00
80
60
40
20
CASÉ B
HOURLY RUNWAY CAPACITY
LEGEND
AUGUST DEMAN
PLUS 10%
AUGUST DEMAN
AUGUST DEMAN
LESS 14%

CASE C


180
160
140
120
100
80
60
40
20
CASE C
HOURLY RUNWAY CAPACITY
LEGEND
AUGUST DEMAN
PLUS 10%
AUGUST DEMAN
AUGUST DEMAN
LESS 14%

DELAY INCREASES DUE TO CLOSURE OF RUNWAY 8R-26L
(MINUTES/AIRCRAFT)

RUNWAY USE	AUGUST 1977 DEMAND LESS 14%	
	PEAK HOUR	DAILY
A	4.5	2.6
B	44.5	40.6
C	1.2	0.7

DELAY INCREASES DUE TO CLOSURE OF RUNWAY 8R-26L
(MINUTES/AIRCRAFT)

RUNWAY USE	AUGUST 1977 DEMAND PLUS 10%	
	PEAK HOUR	DAILY
A	46.0	43.1
B	127.6	120.1
C	2.3	1.6

DELAY INCREASES DUE TO CLOSURE OF RUNWAY 8R-26L
(MINUTES/AIRCRAFT)

RUNWAY USE	AUGUST 1977 DEMAND	
	PEAK HOUR	DAILY
A	17.3	11.9
B	106.8	93.8
C	1.7	1.2

Telephone: (415) 347-9521

February 20, 1978

Mr. Philip LaRochelle, AEM-100
Federal Aviation Administration
300 Independence Avenue, S.W.
Washington, D.C. 20591

Dear Phil:

Following up on our discussion at the Denver Task Force meeting on February 3, 1978, attached is a breakdown of arrival and departure aircraft delays for the Denver experiments concerning the closure of Runway 8R-26L. If you have any questions, please let me know.

Sincerely,

Stephen L. M. Hockaday
Manager

SLMH/jc
Enclosure

cc: Mr. Fred Jaeger

bcc: Mr. Herb Hubbard, UAL
TFD Correspondence
H. Fan

Attachment

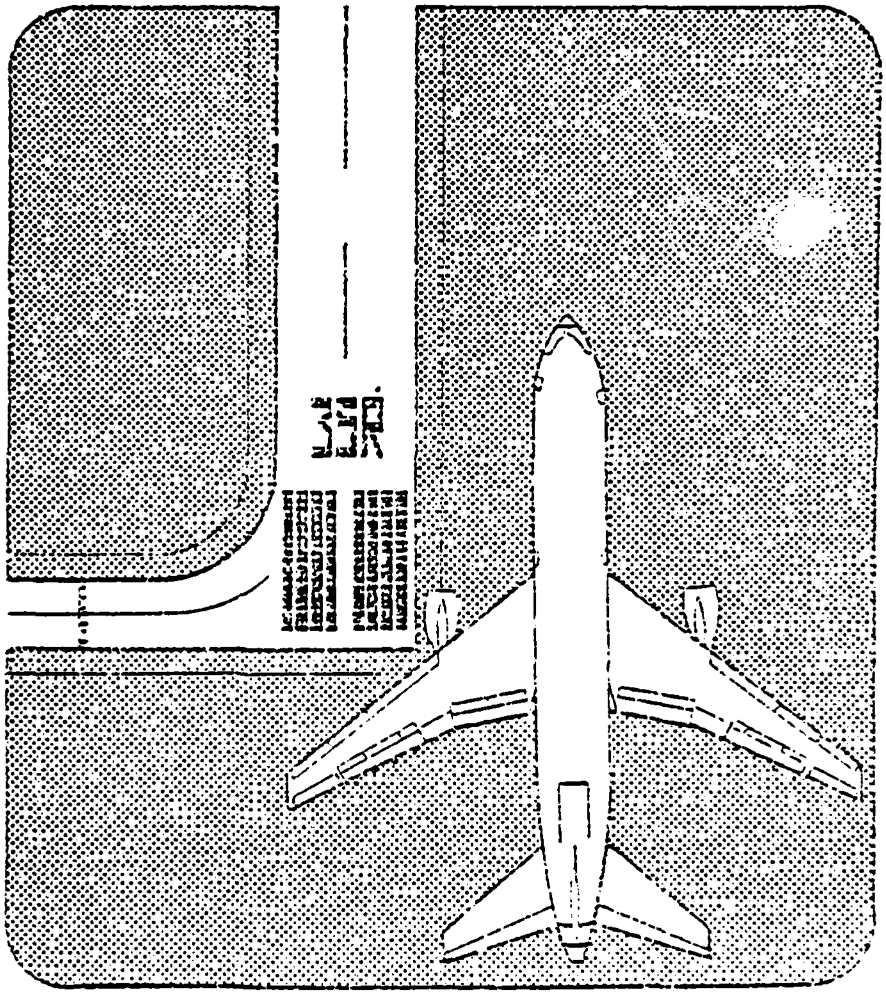
Arrival/Departure Delay Increases Due to
Closure of Runway 8R-26L

		Delay Increase (Minute/aircraft)					
		August 1977 Demand less 14%		August 1977 Demand		August 1977 Demand plus 10%	
Runway Use	Operation Type	Peak Hour	Daily	Peak Hour	Daily	Peak Hour	Daily
A	Arrival	4.0	2.7	14.6	11.5	44.7	47.1
	Departure	4.7	2.6	17.5	12.3	41.8	41.4
B	Arrival	36.5	37.6	78.7	80.6	109.4	111.8
	Departure	49.2	49.8	107.0	108.3	127.5	129.4
C	Arrival	1.0	0.9	1.3	1.4	1.0	1.8
	Departure	0.9	0.5	1.3	0.9	1.5	1.4

STAPLETON INTERNATIONAL AIRPORT

DATA PACKAGE

AIRPORT IMPROVEMENT TASK FORCE DELAY STUDIES



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DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

under contract

DOT FA77WA – 3961

PMM&Co. Peat, Marwick, Mitchell & Co.

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SAN FRANCISCO INTERNATIONAL AIRPORT
SAN FRANCISCO, CALIFORNIA 94128

Telephone: (415) 347-9521

March 2 1978

Mr. Phillip J. LaRochelle AEM-100
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

Re: Input Data for Stapleton Model Calibration and Delay Experiments

Dear Phil:

Enclosed are some data materials that I plan to hand out at the second Stapleton Task Force meeting on March 7 1978:

- Attachment A contains the preliminary calibration data package. Additional data is required from NAFEC and the Task Force to complete this package

- Attachment B contains a preliminary description of the inputs to be changed for each simulation model delay experiment.

- Attachment C contains the preliminary annual delay baseline data package.

- Attachment D contains a preliminary description of the inputs to be changed for each annual delay experiment.

- Attachment E contains a list of additional delay experiments discussed at the previous Task Force meeting.

Mr. Phillip J. LaRochelle
March 2, 1978

Each of these attachments contain information that should be reviewed, revised, and approved by the Stapleton Task Force prior to use in model runs.

After the descriptions in attachments B and D have been approved by the Task Force, we will prepare complete data packages for each experiment.

Sincerely,

Stephen L. M. Hockaday
Manager

SLMH/nbe

Enclosure

cc: Mr. J. R. Dupree (ALG-312)
Mr. F. Jaeger (ARM-4)

Attachment A

PRELIMINARY CALIBRATION DATA PACKAGE

STAPLETON INTERNATIONAL AIRPORT

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.

March 7, 1978

INPUT DATA

a. LOGISTICS

1. Title: Stapleton International Airport Airfield Simulation Model Calibration Run

2. Random Number Seeds: 2017, 3069, 4235, 5873, 6981, 7137, 8099, 9355, 0123, 1985.

3. Start and Finish Times: To be based on reduced field data.

4. Print Options: Detailed run for one random number seed. Summary run for ten random number seeds.

5. Airline Names:

Name	Code
Rocky Mountain	RM
Aspen	AS
United	UA
Braniff	BN
Western	WA
Continental	CO
Trans World	TW
Ozark	OZ
Delta	DL
North Central	NC
Texas International	TI
Frontier	FL
Third Level Carriers	TL

6. Processing Options: First run to check model input. Other runs in COMPUTE mode.

7. Truncation Limits: ± 3 standard deviations.

8. Time Switch: To be based on reduced field data.

b. AIRFIELD PHYSICAL CHARACTERISTICS

9. Airfield Network: See separate drawing.

10. Number of Runways: To be based on reduced field data.

11. Runway Identification: To be based on reduced field data.

12. <u>Departure Runway End Links</u>: To be based on reduced field data.

13. <u>Runway Crossing Links</u>: To be based on reduced field data.

14. <u>Exit Taxiway Location</u>: To be based on existing airfield configuration and only those exits used during field data collection for calibration.

15. <u>Holding Areas</u>: Holding for two aircraft in area south of Concourse B (Taxiway C3/D1 between Runway 7 and Runway 8L). All additional holding will be assumed to occur north of Concourse D in hangar area.

16. <u>Airline Gates</u>:

Airline	Gates
Rocky Mountain	A-01, A-02, A-03E, A-03W
Aspen	A-04, A-06
United	? A-05, A-07, B-07, B-09, B-11, B-15, B-17, B-02, B-04, B-06, B-08, B-10, B-12, B-14, B-16, B-18
Braniff	B-01, B-03, B-05A, B-05B
Western	C-01, C-03, C-05, C-02, C-04, C-06, C-08
Continental	C-07, C-09, C-11, C-15, C-10, C-12, C-14, C-16 C17 ?
Trans World	D-01, D-03, D-05, D-07, D-09, D-11
Ozark	D-15, D-17
Delta	D-21, D-23 ?
North Central	D-32

Texas International	D-30, D-28, D-26
Frontier	D-34, D-24, D-22, D-20, D-18, D-16, D-14, D-12, D-10, D-08, D-06, D-04, D-02
Third Level Carrier	Cargo area by Concourse A

17. General Aviation Basing Areas:

Name	Basing Area Code
Combs Aviation	GC
Beechcraft Aviation	GB
Atlas Aviation	GA
UAL Hangar	T

c. ATC PROCEDURES

18. Aircraft Separations: These values are based on capacity model data--may be revised as a result of reduced field data.

Arrival-Arrival Separation (n.m.) - All cases except as noted.

1. VFR

6 = 18 secs.

		Trail Aircraft Class A	B	C	D	
Lead	A	1.4	2.3	2.8	2.9	0.5
Aircraft	B	1.4	2.4	3.2	3.4	0.7
Class	C	1.9	3.0	3.6	3.6	0.8
	D	3.7	5.1	4.5	4.3	0.8

2. IFR

		Trail Aircraft Class A	B	C	D
Lead	A	3.0	3.0	3.0	3.0
Aircraft	B	3.0	3.0	3.2	3.4
Class	C	4.0	4.0	3.6	3.6
	D	6.0	6.0	5.0	4.3

Departure-Departure Separations (seconds)

1. VFR

		Trail Aircraft Class A	B	C	D
Lead	A	45	45	~~55~~ 60 ✓	55
Aircraft	B	50	~~50~~ 45	60 ✓	60
Class	C	~~55~~ 50	~~60~~ 65	60 ✓	60 ✓
	D	120 ✓	120	~~120~~ 105	100

5 secs

2. IFR

		Trail Aircraft Class A	B	C	D
Lead	A	60	60	60	60
Aircraft	B	60	60	60	60
Class	C	60	60	60	60
	D	120	120	120	100

19. Route Data: See Figure 1.

20. Two-Way Path Data:

Two-way taxiways are located as follows:

1. Taxiway C2 between Runway 8L and apron taxiway to south of Concourse B.
2. Taxiway C3.
3. Taxiway C4.
4. Apron Taxiway to south of Concourse B.
5. Apron Taxiway between Concourse B and Concourse C.
6. Apron Taxiway between Concourse C and Concourse D.

21. Common Approach Paths:

Arrival Runway	Aircraft Class	Length of Common Approach Path
25	A	1.0
26R	A	3.0
	B	3.0
	C	5.5
	D	5.5
26L	A	5.5
	B	5.5
	C	5.5
	D	5.5

22. Vectoring Delays:

This input normally allocates delays among vectoring and holding. With profile descent at Stapleton, holding occurs rarely, if ever.

Model input values will be used that preclude holding for arrival aircraft.

23. Departure Runway Queue Control:

Departure Runway	Departure queue length for diversion to alternative runway
35L (Air Carrier)	5 (then divert to 35R)
35R (Air Carrier)	No diversion
26R (GA)	No diversion

24. Gate Hold Control:

Hold aircraft at gate when departure queue at runway is 10 or more.

25. Departure Airspace Constraints:

Aircraft are not held at gate due to departure airspace constraints. Flow control constraints from other Centers do not normally occur.

26. Inter-Arrival Gap:

With this runway use, arrival aircraft are not delayed in the arrival airspace to release departures.

27. Runway Crossing Delay Control:

Arrival and departure runway operations are only interrupted for a taxiing aircraft to cross an active runway when the taxiing aircraft is delayed by 5 minutes or more.

d. AIRCRAFT OPERATIONAL CHARACTERISTICS

28. Exit Taxiway Utilization:

Exit Utilization (percent)

	A/C Class	350 C-8	351 C-7	354 C-5	356 C-4	357 C-3	358 C-2	359 End
Runway 26L	A	~~96~~	~~4~~	100				
	B	~~33~~	~~67~~	54	15	31		
	C		~~2~~	~~60~~ 34	~~36~~ 54	2 22		
	D			~~25~~	~~61~~ 50	~~11~~ 50	~~3~~	

	A/C Class	347 D-3	318 D-2	316 C-4	D-1	311 C-3	425 End
Runway 26R	A	~~84~~ 48	~~15~~ 52				
	B	~~9~~	~~91~~ 44	17		39	
	C		7 32	~~49~~ 47		37 21	~~7~~
	D			~~20~~		~~45~~	~~35~~ 100

	A/C Class	322 D-3	End
Runway 25	A	100	
	B	100	

29. Arrival Runway Occupancy Times:

Runway Occupancy Time (seconds)

	A/C Class	350 C-8	351 C-7	354 C-5	356 C-4	357 C-3	358 C-2	359 End
Runway 26L	A	~~45~~	~~60~~	60				
	B	~~38~~	51	45	60	70		
	C		35	~~50~~ 41	~~60~~ 54	~~68~~ 58		
	D			52	62 51	~~70~~ 60	76	

	A/C Class	347 D-3	318 D-2	316 C-4	315 D-1	311 C-3	425 End
Runway 26R	A	~~45~~ 37	65 ~~55~~				
	B	~~40~~	~~56~~ 36	49		61	
	C		~~39~~ 31	~~48~~ 47		~~36~~ 55	~~64~~
	D		~~47~~	~~50~~		~~58~~	~~67~~ 60

	A/C Class	D-3	End
Runway 25	A	45	
	B	40	

30. Touch & Go Occupancy Times:

Aircraft Class	Runway Occupancy Time (seconds) Mean	Standard Deviation
A	22	~~7~~ 3
B	23	~~7~~ 3
C	27	~~7~~ 4
D	27	~~7~~ 4

31. Departure Runway Occupancy Times:

Aircraft Class	Runway Occupancy Time (seconds) Mean	Standard Deviation
A	23	~~8~~ 3
B	26	~~8~~ 3
C	37	~~8~~ 4
D	37	~~8~~ 4

32. Taxi Speeds: To be based on reduced field data.

33. Approach Speeds:

Aircraft Class	Approach Speed (Knots) Mean	Standard Deviation
A	100	10
B	135	10
C	155	10
D	160	10

34. Gate Service Times: To be supplied by Task Force.

35. Airspace Travel Times: To be based on reduced field data.

36. Runway Crossing Times: To be based on reduced field data.

37. Lateness Distribution: To be supplied by Task Force.

38. Demand: To be based on reduced field data.

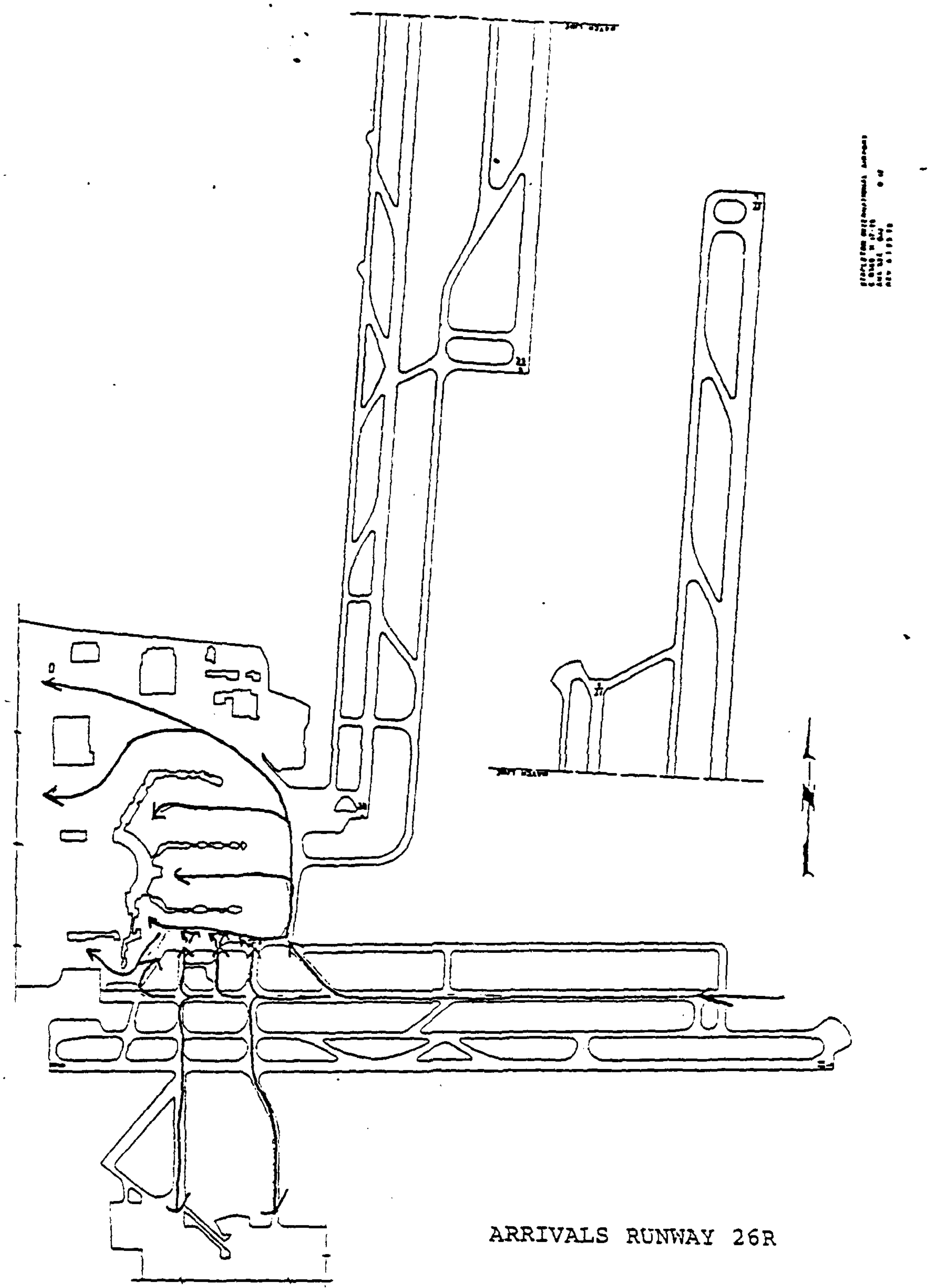
OUTPUT DATA

A. Flow Rates: To be based on reduced field data.

B. Delays: To be based on reduced field data.

C Travel Times: To be based on reduced field data.

Figure 1

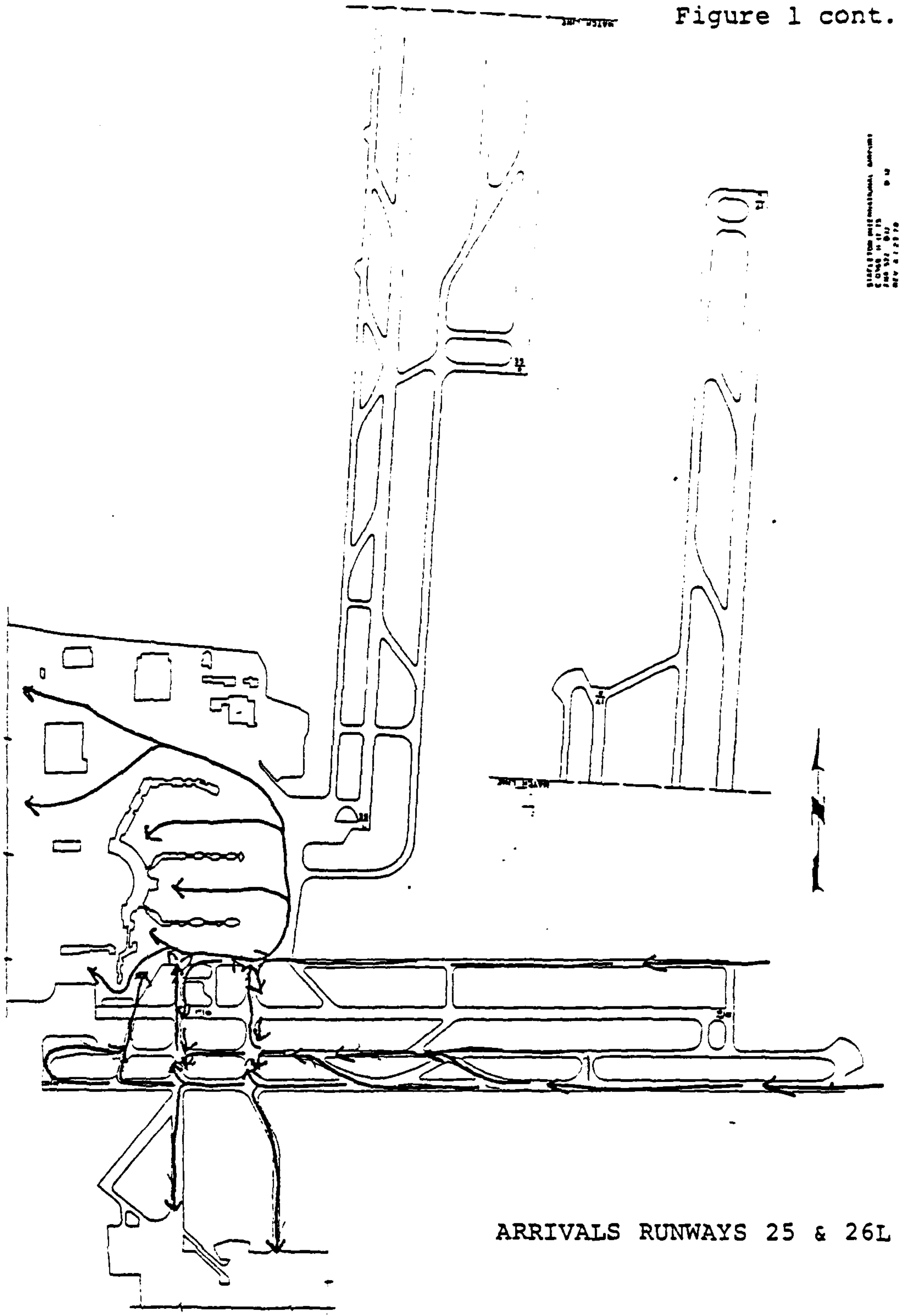


ARRIVALS RUNWAY 26R

See notes ① ② for 26L

Source: NAFEC

Figure 1 cont.



ARRIVALS RUNWAYS 25 & 26L

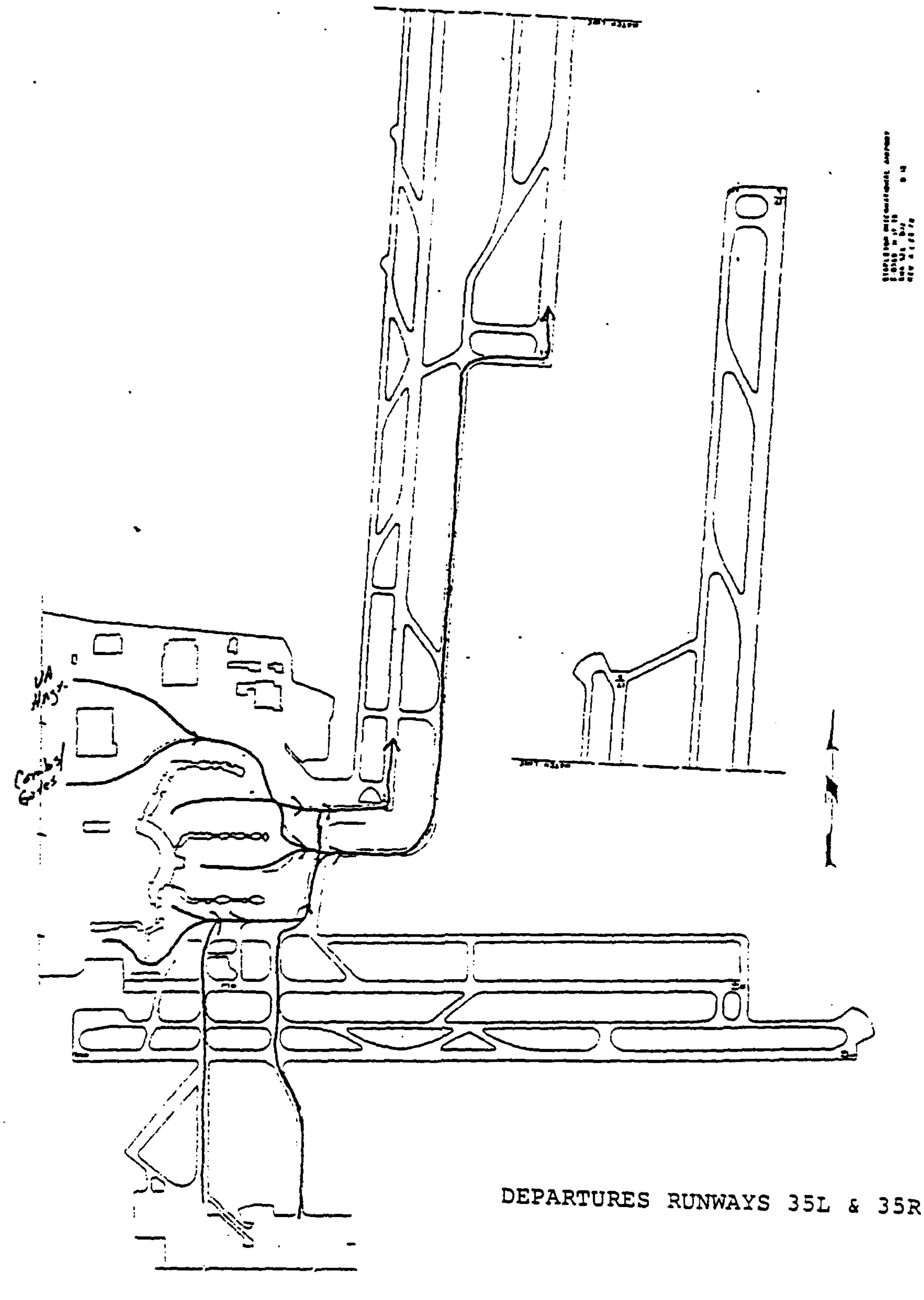
① C2 + C3 are used by UA for gates on southside of B concourse

② C3 is used by BN for their gates

③ Only aircraft weighing 12500 + above may remain on the runway + turn southbound on C4
All others exit via C5 or C7 thence to C4.

Arrivals 26L + 25

Source: NAFEC



DEPARTURES RUNWAYS 35L & 35R

Source: NAFEC

Attachment B

PRELIMINARY DESCRIPTION OF INPUTS TO BE CHANGED FOR SIMULATION MODEL DELAY EXPERIMENTS

STAPLETON INTERNATIONAL AIRPORT

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.

March 7, 1978

INPUT CHANGES FOR SIMULATION EXPERIMENT NUMBER 1

Inputs for this experiment are identical to inputs for calibration run ~~experiment number~~ ____ except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVEMENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title		■			1
2 Random number seeds					2
3 Start and finish times		■			3
4 Print options		■			4
5 Airline names		■			5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network			■		9
10 Number of runways					10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links					13
14 Exit taxiway location			■		14
15 Holding areas					15
16 Airline gates		■	■		16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations			■	■	18
19 Route data			■		19
20 Two-way path data			■		20
21 Common approach paths					21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization			■		28
29 Arrival runway occupancy times			■		29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times		■			34
35 Airspace travel times					35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand		■			38

Inputs for this experiment are identical to inputs for ~~[illegible]~~ experiment number 1 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title	■				1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways					10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links					13
14 Exit taxiway location					14
15 Holding areas					15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations	■				18
19 Route data					19
20 Two-way path data					20
21 Common approach paths					21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization					28
29 Arrival runway occupancy times					29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times					35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand	■				38

INPUT CHANGES FOR SIMULATION EXPERIMENT NUMBER 3

Inputs for this experiment are identical to inputs for ~~[illegible]~~ experiment number 2 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title	■				1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways					10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links					13
14 Exit taxiway location					14
15 Holding areas					15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations	■				18
19 Route data					19
20 Two-way path data					20
21 Common approach paths	■				21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization	■				28
29 Arrival runway occupancy times	■				29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times	■				35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand	■				38

INPUT CHANGES FOR SIMULATION EXPERIMENT NUMBER ___-___

Inputs for this experiment are identical to inputs for ~~[illegible]~~ experiment number 1 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVEMENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title	■				1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways					10
11 Runway identification	■				11
12 Departure runway end links	■				12
13 Runway crossing links	■				13
14 Exit taxiway location	■				14
15 Holding areas	■				15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations	■				18
19 Route data	■				19
20 Two-way path data	■				20
21 Common approach paths	■				21
22 Vectoring delays					22
23 Departure runway queue control	■				23
24 Gate hold control	■				24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization	■				28
29 Arrival runway occupancy times	■				29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times	■				35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand	■				38

Inputs for this experiment are identical to inputs for ~~[illegible]~~ experiment number 1 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title			■		1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways					10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links					13
14 Exit taxiway location					14
15 Holding areas					15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations			■		18
19 Route data					19
20 Two-way path data					20
21 Common approach paths					21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization					28
29 Arrival runway occupancy times					29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times			■		35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand					38

Inputs for this experiment are identical to inputs for ~~[illegible]~~ experiment number 1 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title			■		1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network			■		9
10 Number of runways					10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links					13
14 Exit taxiway location			■		14
15 Holding areas					15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations					18
19 Route data			■		19
20 Two-way path data			■		20
21 Common approach paths					21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization			■		28
29 Arrival runway occupancy times			■		29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times					35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand					38

Inputs for this experiment are identical to inputs for ~~[illegible]~~ experiment number 1 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVEMENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title			■		1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways					10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links					13
14 Exit taxiway location					14
15 Holding areas					15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations					18
19 Route data					19
20 Two-way path data					20
21 Common approach paths					21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization					28
29 Arrival runway occupancy times					29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times					35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand			■		38

INPUT CHANGES FOR SIMULATION EXPERIMENT NUMBER ______

Inputs for this experiment are identical to inputs for experiment number 2 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title			■		1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways					10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links					13
14 Exit taxiway location					14
15 Holding areas					15
16 Airline gates			■		16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations					18
19 Route data					19
20 Two-way path data					20
21 Common approach paths					21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization					28
29 Arrival runway occupancy times					29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times					35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand			■		38

INPUT CHANGES FOR SIMULATION

Inputs for this experiment are identical to inputs for ~~[illegible]~~ experiment number 3 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title			■		1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways					10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links					13
14 Exit taxiway location					14
15 Holding areas					15
16 Airline gates			■		16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations					18
19 Route data					19
20 Two-way path data					20
21 Common approach paths					21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization					28
29 Arrival runway occupancy times					29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times					35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand			■		38

Inputs for this experiment are identical to inputs for [redacted] experiment number 4 except as indicated below.

IFR2
weather

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVEMENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title	■				1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways					10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links					13
14 Exit taxiway location					14
15 Holding areas					15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations	■				18
19 Route data					19
20 Two-way path data					20
21 Common approach paths	■				21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization	■				28
29 Arrival runway occupancy times	■				29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds	■				32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times	■				35
36 Runway crossing times	■				36
37 Lateness distribution					37
38 Demand	■				38

INPUT CHANGES FOR SIMULATION EXPERIMENT

Inputs for this experiment are identical to inputs for ~~[illegible]~~ experiment number 1 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVEMENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title	■				1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways	■				10
11 Runway identification	■				11
12 Departure runway end links					12
13 Runway crossing links	■				13
14 Exit taxiway location	■				14
15 Holding areas	■				15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations	■				18
19 Route data	■				19
20 Two-way path data	■				20
21 Common approach paths	■				21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization	■				28
29 Arrival runway occupancy times	■				29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times	■				35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand	■				38

INPUT CHANGES FOR SIMULATION [illegible]

Inputs for this experiment are identical to inputs for [illegible] experiment number 4 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVEMENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title			■		1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways					10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links					13
14 Exit taxiway location					14
15 Holding areas					15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations					18
19 Route data					19
20 Two-way path data					20
21 Common approach paths					21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization					28
29 Arrival runway occupancy times					29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times					35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand			■		38

INPUT CHANGES FOR SIMULATION EXPERIMENT NUMBER 16

Inputs for this experiment are identical to inputs for ~~[illegible]~~ experiment number 15 except as indicated below.

	SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
	ogistics					
1	Title			■		1
	Random number seeds					2
	Start and finish times					3
4	Print options					4
5	Airline names					5
6	Processing options					6
7	Truncation limits					7
8	Time switch					8
	Airfield Physical Characteristics					
9	Airfield network					9
10	Number of runways					10
11	Runway identification					11
12	Departure runway end links					12
	Runway crossing links					13
	Exit taxiway location					14
15	Holding areas					15
16	Airline gates					16
17	General aviation basing areas					17
	ATC Procedures					
18	Aircraft separations					18
19	Route data					19
20	Two-way path data					20
	ommon approach paths					21
22	Vectoring delays					22
23	Departure runway queue control					23
24	Gate hold control					24
25	Departure airspace constraints					25
26	Departure queue					26
27	Runway crossing delay control					27
	ircraft Operational Characteristics					
28	Exit taxiway utilization			■		28
29	Arrival runway occupancy times			■		29
30	Touch-and-go runway occupancy times					30
31	Departure runway occupancy times					31
	Taxi speeds			■		32
	Approach speeds					33
34	Gate service times					34
35	Airspace travel times					35
36	Runway crossing times			■		36
37	Lateness distribution					37
38	Demand					38

Inputs for this experiment are identical to inputs for [redacted] experiment number 16 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title			■		1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways					10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links					13
14 Exit taxiway location					14
15 Holding areas					15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations					18
19 Route data					19
20 Two-way path data					20
21 Common approach paths					21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization			■		28
29 Arrival runway occupancy times			■		29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times					35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand					38

Inputs for this experiment are identical to inputs for experiment number 16 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title			■		1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways					10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links					13
14 Exit taxiway location					14
15 Holding areas					15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations					18
19 Route data					19
20 Two-way path data					20
21 Common approach paths					21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization			■		28
29 Arrival runway occupancy times			■		29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times					35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand			■		38

INPUT CHANGES FOR SIMULATION

Inputs for this experiment are identical to inputs for ~~[illegible]~~ experiment number 1 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title			■		1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways					10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links					13
14 Exit taxiway location					14
15 Holding areas					15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations			■		18
19 Route data					19
20 Two-way path data					20
21 Common approach paths					21
22 Vectoring delays			■		22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization					28
29 Arrival runway occupancy times					29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times			■		35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand					38

Deletes profile descent

INPUT CHANGES FOR SIMULATION EXPERIMENT NUMBER 22

Inputs for this experiment are identical to inputs for ~~[illegible]~~ experiment number 1 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVEMENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title			■		1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways					10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links					13
14 Exit taxiway location					14
15 Holding areas					15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations			■		18
19 Route data					19
20 Two-way path data					20
21 Common approach paths					21
22 Vectoring delays			■		22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization					28
29 Arrival runway occupancy times					29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times			■		35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand					38

INPUT CHANGES FOR SIMULATION EXPERIMENT NUMBER 23

Inputs for this experiment are identical to inputs for experiment number 1 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title			■		1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network			■		9
10 Number of runways					10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links					13
14 Exit taxiway location					14
15 Holding areas			■		15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations					18
19 Route data			■		19
20 Two-way path data			■		20
21 Common approach paths					21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control			■		24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization					28
29 Arrival runway occupancy times					29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times					35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand					38

INPUT CHANGES FOR SIMULATION EXPERIMENT NUMBER [illegible]

Inputs for this experiment are identical to inputs for ~~[illegible]~~ experiment number 1 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title			■		1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network			■		9
10 Number of runways					10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links					13
14 Exit taxiway location					14
15 Holding areas			■		15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations					18
19 Route data			■		19
20 Two-way path data			■		20
21 Common approach paths					21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control			■		24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization					28
29 Arrival runway occupancy times					29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times					35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand					38

Inputs for this experiment are identical to inputs for calibration run ~~experiment number~~ ____ except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title			■		1
2 Random number seeds					2
3 Start and finish times			■		3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways			■		10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links			■		13
14 Exit taxiway location					14
15 Holding areas			■		15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations			■		18
19 Route data			■		19
20 Two-way path data			■		20
21 Common approach paths			■		21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization			■		28
29 Arrival runway occupancy times			■		29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times					35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand			■		38

[illegible]

Inputs for this experiment are identical to inputs for calibration run ~~[illegible]~~ ____ except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title			■		1
2 Random number seeds					2
3 Start and finish times			■		3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways			■		10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links			■		13
14 Exit taxiway location					14
15 Holding areas			■		15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations			■		18
19 Route data			■		19
20 Two-way path data			■		20
21 Common approach paths			■		21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization			■		28
29 Arrival runway occupancy times			■		29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times					35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand			■		38

Inputs for this experiment are identical to inputs for ~~[illegible]~~ experiment number 4 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVEMENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title	■				1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways					10
11 Runway identification	■				11
12 Departure runway end links	■				12
13 Runway crossing links	■				13
14 Exit taxiway location	■				14
15 Holding areas	■				15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations	■				18
19 Route data	■				19
20 Two-way path data	■				20
21 Common approach paths					21
22 Vectoring delays					22
23 Departure runway queue control	■				23
24 Gate hold control	■				24
25 Departure airspace constraints					25
26 Departure queue	■				26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization					28
29 Arrival runway occupancy times					29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times	■				35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand	■				38

Inputs for this experiment are identical to inputs for [illegible] experiment number 31 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title			■		1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network			■		9
10 Number of runways					10
11 Runway identification					11
12 Departure runway and links					12
13 Runway crossing links					13
14 Exit taxiway location			■		14
15 Holding areas					15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations					18
19 Route data			■		19
20 Two-way path data			■		20
21 Common approach paths					21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization			■		28
29 Arrival runway occupancy times			■		29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times					35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand					38

Inputs for this experiment are identical to inputs for [redacted] experiment number 1 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title	■				1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways					10
11 Runway identification	■				11
12 Departure runway and links					12
13 Runway crossing links	■				13
14 Exit taxiway location	■				14
15 Holding areas	■				15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations	■				18
19 Route data	■				19
20 Two-way path data	■				20
21 Common approach paths	■				21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue	■				26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization	■				28
29 Arrival runway occupancy times	■				29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times	■				35
36 Runway crossing times	■				36
37 Lateness distribution					37
38 Demand	■				38

Inputs for this experiment are identical to inputs for ~~[illegible]~~ experiment number 33 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVEMENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title			■		1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways					10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links			■		13
14 Exit taxiway location			■		14
15 Holding areas					15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations			■		18
19 Route data			■		19
20 Two-way path data			■		20
21 Common approach paths			■		21
22 Vectoring delays					22
23 Departure runway queue control			■		23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization			■		28
29 Arrival runway occupancy times			■		29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times			■		35
36 Runway crossing times			■		36
37 Lateness distribution					37
38 Demand			■		38

Inputs for this experiment are identical to inputs for ~~[illegible]~~ experiment number 7 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title			■		1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways					10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links					13
14 Exit taxiway location					14
15 Holding areas					15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations					18
19 Route data					19
20 Two-way path data					20
21 Common approach paths					21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization					28
29 Arrival runway occupancy times					29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times					35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand			■		38

Inputs for this experiment are identical to inputs for ~~[illegible]~~ experiment number 14 except as indicated below.

SIMULATION MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
a. Logistics					
1 Title			■		1
2 Random number seeds					2
3 Start and finish times					3
4 Print options					4
5 Airline names					5
6 Processing options					6
7 Truncation limits					7
8 Time switch					8
b. Airfield Physical Characteristics					
9 Airfield network					9
10 Number of runways					10
11 Runway identification					11
12 Departure runway end links					12
13 Runway crossing links					13
14 Exit taxiway location					14
15 Holding areas					15
16 Airline gates					16
17 General aviation basing areas					17
c. ATC Procedures					
18 Aircraft separations					18
19 Route data					19
20 Two-way path data					20
21 Common approach paths					21
22 Vectoring delays					22
23 Departure runway queue control					23
24 Gate hold control					24
25 Departure airspace constraints					25
26 Departure queue					26
27 Runway crossing delay control					27
d. Aircraft Operational Characteristics					
28 Exit taxiway utilization					28
29 Arrival runway occupancy times					29
30 Touch-and-go runway occupancy times					30
31 Departure runway occupancy times					31
32 Taxi speeds					32
33 Approach speeds					33
34 Gate service times					34
35 Airspace travel times					35
36 Runway crossing times					36
37 Lateness distribution					37
38 Demand			■		38

Attachment C

PRELIMINARY ANNUAL DELAY BASELINE DATA PACKAGE

STAPLETON INTERNATIONAL AIRPORT

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.

March 7, 1978

INPUT DATA

1. Annual Demand: 465,946 (1977)

2. Group Specification:

3 day groups	:	High, Average, Low
12 week groups	:	12 months, January through December
3 weather groups	:	VFR, IFR1, IFR2

7 runway uses :

	Arrivals Runway	Departures Runway
1.	25, 26	35
2.	35R	35L
3.	17	7, 8
4.	25, 26	26
5.	8	35
6.	17	17
7.	8	7, 8

3. Weekly Traffic:

Week Group	1	2	3	4	5	6	7	8	9	10	11	12
% of annual in one week	1.84	1.88	1.84	1.81	1.80	1.95	2.03	2.11	2.01	1.91	1.86	1.96

4. Number of Weeks in Each Group:

Week Group	1	2	3	4	5	6	7	8	9	10	11	12
Number of weeks	4.43	4.00	4.43	4.29	4.43	4.29	4.43	4.43	4.29	4.43	4.29	4.43

5. Daily Traffic:

Day Group	1	2	3
% of weekly in one day	14.9	14.5	13.4

6. Number of Days in Each Group:

Day Group	1	2	3
Number of Days	2	3	2

7. Weather Group Demand Factors:

VFR: 1.00
IFR1: 0.75
IFR2: 0.50

8. Weather Occurrences:

Week Group	1	2	3	4	5	6	7	8	9	10	11	12
% VFR	97.5	95.1	95.6	95.7	98.9	99.6	99.5	99.6	99.1	97.6	97.1	97.5
% IFR1	1.3	1.7	2.1	2.1	0.4	0.1	0.2	0.1	0.1	0.7	1.4	1.0
% IFR2	1.2	3.2	2.3	2.2	0.7	0.3	0.3	0.3	0.8	1.7	1.5	1.5

9. Hourly Runway Capacity:

	Hourly Capacity		
Runway Use	VFR	IFR1	IFR2
1	170	75	71
2	85	74	70
3	137	74	71
4	95	74	70
5	150	76	71
6	83	74	70
7	93	74	70

10. Runway Use Occurrences:

	Percent Occurrence		
Runway Use	VFR	IFR1	IFR2
1	60.00	2.50	2.50
2	--	--	1.00
3	22.00	0.05	0.05
4	3.00	--	--
5	4.00	0.05	--
6	2.00	--	--
7	1.50	--	--
Other runway uses	1.35%		

11. Hourly Traffic:

Hour	% daily traffic	Hour	% daily traffic	Hour	% daily traffic	Hour	% daily traffic
00-01	0.8	06-07	1.8	12-13	7.8	18-19	6.5
01-02	0.6	07-08	4.5	13-14	5.9	19-20	5.7
02-03	0.1	08-09	5.5	14-15	7.2	20-21	4.1
03-04	0.4	09-10	7.0	15-16	5.3	21-22	4.1
04-05	0.4	10-11	6.8	16-17	5.9	22-23	3.5
05-06	1.4	11-12	6.1	17-18	6.2	23-24	2.4

12. Demand Profile Factor: 35%

13. Runway Use Demand Factor:

All runway uses accommodate air carrier and general aviation demand (Demand factor = 1.0)

14. Aircraft Mix: 19% Class A
21% Class B
51% Class C
9% Class D

15. Percent Arrivals:

Hour	% Arrivals	Hour	% Arrivals	Hour	% Arrivals	Hour	% Arrivals
00-01	50	06-07	50	12-13	45	18-19	50
01-02	50	07-08	50	13-14	53	19-20	51
02-03	50	08-09	58	14-15	42	20-21	49
03-04	50	09-10	52	15-16	50	21-22	50
04-05	50	10-11	50	16-17	51	22-23	50
05-06	50	11-12	56	17-18	64	23-24	50

16. User-Specified Title: SIA ANNUAL BASELINE

Attachment D

PRELIMINARY DESCRIPTION OF INPUTS TO BE CHANGED FOR ANNUAL DELAY EXPERIMENTS

STAPLETON INTERNATIONAL AIRPORT

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.

March 7, 1978

EXPERIMENT NUMBER 8 IS THE ANNUAL DELAY
BASELINE RUN.

INPUT CHANGES FC .NNUAL DELAY EXPE .ENT NUMBER 9

Inputs for this experiment are identical to inputs for ~~baseline run~~ experiment number 10 except as indicated below.

ANNUAL DELAY MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
1 Annual demand			■		1
2 Group specification					2
3 Weekly traffic			■		3
4 Number of weeks in each group					4
5 Daily traffic			■		5
6 Number of days in each group					6
7 Weather group demand factors			■		7
8 Weather occurrences					8
9 Hourly runway capacity			■		9
10 Runway use occurrences			■		10
11 Hourly traffic			■		11
12 Demand profile factor			■		12
13 Runway use demand factor					13
14 Aircraft mix			■		14
15 Percent arrivals			■		15
16 User-specified title			■		16

INPUT CHANGES FO. .NNUAL DELAY EXPE. .ENT NUMBER 10

Inputs for this experiment are identical to inputs for ~~baseline run~~ experiment number 12 except as indicated below.

ANNUAL DELAY MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVEMENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
1 Annual demand					1
2 Group specification					2
3 Weekly traffic					3
4 Number of weeks in each group					4
5 Daily traffic					5
6 Number of days in each group					6
7 Weather group demand factors					7
8 Weather occurrences					8
9 Hourly runway capacity				■	9
10 Runway use occurrences					10
11 Hourly traffic					11
12 Demand profile factor					12
13 Runway use demand factor					13
14 Aircraft mix					14
15 Percent arrivals					15
16 User-specified title				■	16

INPUT CHANGES FC ANNUAL DELAY EXPE IENT NUMBER 11

Inputs for this experiment are identical to inputs for ~~baseline run~~ experiment number 12 except as indicated below.

ANNUAL DELAY MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVEMENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
1 Annual demand			■		1
2 Group specification					2
3 Weekly traffic			■		3
4 Number of weeks in each group					4
5 Daily traffic			■		5
6 Number of days in each group					6
7 Weather group demand factors			■		7
8 Weather occurrences					8
9 Hourly runway capacity			■		9
10 Runway use occurrences			■		10
11 Hourly traffic			■		11
12 Demand profile factor			■		12
13 Runway use demand factor					13
14 Aircraft mix			■		14
15 Percent arrivals			■		15
16 User-specified title			■		16

INPUT CHANGES FOR ANNUAL DELAY EXPERIMENT NO. ?

Inputs for this experiment are identical to inputs for baseline run/experiment number 8 except as indicated below.

ANNUAL DELAY MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
1 Annual demand		■			1
2 Group specification					2
3 Weekly traffic		■			3
4 Number of weeks in each group					4
5 Daily traffic		■			5
6 Number of days in each group					6
7 Weather group demand factors		■			7
8 Weather occurrences					8
9 Hourly runway capacity		■			9
10 Runway use occurrences		■			10
11 Hourly traffic		■			11
12 Demand profile factor		■			12
13 Runway use demand factor					13
14 Aircraft mix		■			14
15 Percent arrivals		■			15
16 User-specified title		■			16

INPUT CHANGES FC ANNUAL DELAY EXPI MENT NUMBER 27

Inputs for this experiment are identical to inputs for ~~baseline run~~ experiment number 29 except as indicated below.

ANNUAL DELAY MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
1 Annual demand					1
2 Group specification					2
3 Weekly traffic					3
4 Number of weeks in each group					4
5 Daily traffic					5
6 Number of days in each group					6
7 Weather group demand factors					7
8 Weather occurrences					8
9 Hourly runway capacity				■	9
10 Runway use occurrences					10
11 Hourly traffic					11
12 Demand profile factor					12
13 Runway use demand factor					13
14 Aircraft mix					14
15 Percent arrivals					15
16 User-specified title				■	16

INPUT CHANGES FOR ANNUAL DELAY EXPERIMENT NUMBER [illegible]

Inputs for this experiment are identical to inputs for ~~baseline run~~ experiment number 30 except as indicated below.

ANNUAL DELAY MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
1 Annual demand					1
2 Group specification					2
3 Weekly traffic					3
4 Number of weeks in each group					4
5 Daily traffic					5
6 Number of days in each group					6
7 Weather group demand factors					7
8 Weather occurrences					8
9 Hourly runway capacity				■	9
10 Runway use occurrences					10
11 Hourly traffic					11
12 Demand profile factor					12
13 Runway use demand factor					13
14 Aircraft mix					14
15 Percent arrivals					15
16 User-specified title				■	16

INPUT CHANGES I ANNUAL DELAY EXI .MENT NUMBER 29

Inputs for this experiment are identical to inputs for ~~baseline run~~ experiment number 30 except as indicated below.

ANNUAL DELAY MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVEMENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
1 Annual demand			■		1
2 Group specification					2
3 Weekly traffic			■		3
4 Number of weeks in each group					4
5 Daily traffic			■		5
6 Number of days in each group					6
7 Weather group demand factors			■		7
8 Weather occurrences					8
9 Hourly runway capacity			■		9
10 Runway use occurrences			■		10
11 Hourly traffic			■		11
12 Demand profile factor			■		12
13 Runway use demand factor					13
14 Aircraft mix			■		14
15 Percent arrivals			■		15
16 User-specified title			■		16

INPUT CHANGES F ANNUAL DELAY EXP MENT NUMBER 30

Inputs for this experiment are identical to inputs for baseline run/experiment number 8 except as indicated below.

ANNUAL DELAY MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
1 Annual demand		■			1
2 Group specification					2
3 Weekly traffic		■			3
4 Number of weeks in each group					4
5 Daily traffic		■			5
6 Number of days in each group					6
7 Weather group demand factors		■			7
8 Weather occurrences					8
9 Hourly runway capacity		■			9
10 Runway use occurrences		■			10
11 Hourly traffic		■			11
12 Demand profile factor		■			12
13 Runway use demand factor					13
14 Aircraft mix		■			14
15 Percent arrivals		■			15
16 User-specified title		■			16

INPUT CHANGES F(ANNUAL DELAY EXPI MENT NUMBER 35

Inputs for this experiment are identical to inputs for ~~baseline run~~ experiment number 27 except as indicated below.

ANNUAL DELAY MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVE-MENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
1 Annual demand			■		1
2 Group specification					2
3 Weekly traffic			■		3
4 Number of weeks in each group					4
5 Daily traffic			■		5
6 Number of days in each group					6
7 Weather group demand factors					7
8 Weather occurrences					8
9 Hourly runway capacity			■		9
10 Runway use occurrences					10
11 Hourly traffic			■		11
12 Demand profile factor			■		12
13 Runway use demand factor					13
14 Aircraft mix			■		14
15 Percent arrivals			■		15
16 User-specified title			■		16

INPUT CHANGES F ANNUAL DELAY EXP. MENT NUMBER 36

Inputs for this experiment are identical to inputs for ~~baseline run~~ experiment number 35 except as indicated below.

ANNUAL DELAY MODEL INPUTS	STUDY CASES	DEMAND	NEAR-TERM IMPROVEMENTS	ATC SYSTEM SCENARIOS	INPUT NUMBER
1 Annual demand			■		1
2 Group specification					2
3 Weekly traffic			■		3
4 Number of weeks in each group					4
5 Daily traffic			■		5
6 Number of days in each group					6
7 Weather group demand factors					7
8 Weather occurrences					8
9 Hourly runway capacity			■		9
10 Runway use occurrences					10
11 Hourly traffic			■		11
12 Demand profile factor			■		12
13 Runway use demand factor					13
14 Aircraft mix			■		14
15 Percent arrivals			■		15
16 User-specified title			■		16

Attachment E

ADDITIONAL DELAY EXPERIMENTS

STAPLETON INTERNATIONAL AIRPORT

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.

March 7 1978

Attachment E

ADDITIONAL DELAY EXPERIMENTS

Experiment Number	Model	Study Case	Arrival Runways	Departure Runways	Weather	Demand	ATC System Scenario	Near-Term Improvements
31	ASM	9	17L-17R	17L-17R	VFR1	Pre-1985	Pre-1985	Pre-1985
32	ASM	9	17L-17R	17L-17R	VFR1	Pre-1985	Pre-1985	HSE 17L[a]
33	ASM	11	35L	35L-35R	VFR1	Pre-1985	Pre-1985	Pre-1985
34	ASM	11	35L-35R	35L-35R	VFR1	Pre-1985	Pre-1985	A35L-35R[b]
35	ADM	n.a.	n.a.	n.a.	n.a.	Post-1985	Post-1985	Forecast Variation
36	ADM	n.a.	n.a.	n.a.	n.a.	Post-1985	Post-1985	Forecast Variation
37	ASM	1	26L-26R	35L-35R	VFR1	Pre-1985	Pre-1985	± 19
38	ASM	7	26L-26R	35L-35%	IFR1	Pre-1985	Pre-1985	± 19
39	DDC[c]		25, 26L-26R	35L-35R	VFR1	1978	Todays	None
40	DDC[c]		25, -26R	35L-35R	VFR1	1978	Todays	26L dated
41	DDC[c]		17L-17R	7, 8L, 17L-17R	VFR1	1978	Todays	26L dated
42	DDC[c]		17L-17R	17L-17R	VFR1	1978	Todays	26L dated

a. High Speed Exit 17L
b. Dual ILS arrivals 35L and 35R
c. Daily delay computation

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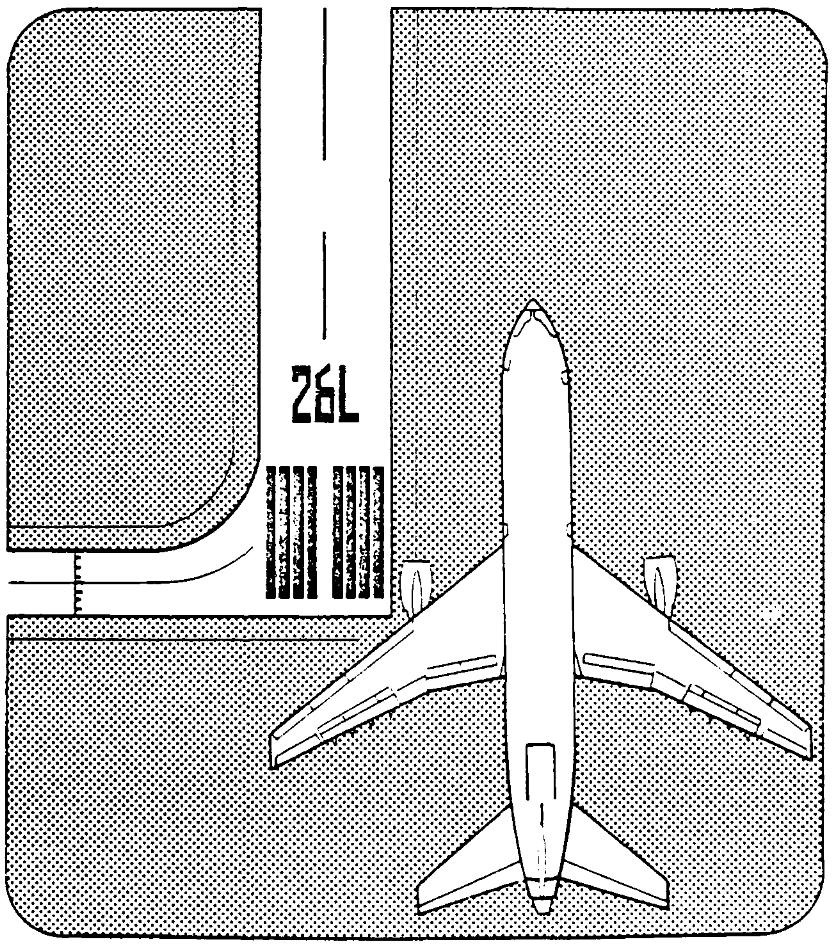
STAPLETON INTERNATIONAL AIRPORT

DATA PACKAGE NO. 2

AIRPORT IMPROVEMENT TASK FORCE DELAY STUDIES



prepared for

DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

under contract

DOT FA77WA -3961

PMM&Co. Peat, Marwick, Mitchell & Co.

JUNE 1978

PEAT, MARWICK, MITCHELL & CO.
P. O. BOX 8007
SAN FRANCISCO INTERNATIONAL AIRPORT
SAN FRANCISCO, CALIFORNIA 94128

Telephone: (415) 347-9521

June 8, 1978

Mr. Ray Fowler, AEM-100
Federal Aviation Authority
800 Independence Ave., S.W.
Washington, D.C. 20591

Re: Input Data for Stapleton Delay Experiments

Dear Ray:

Enclosed is the input data package for Stapleton Stage I delay experiments that I plan to handout at the Stapleton Task Force Meeting on June 12, 1978. Additional data is required from the Stapleton Task Force to complete this package. Under separate cover I am also forwarding the Stapleton airfield networks for 1978 baseline case and 1985 baseline case.

The enclosed data package and the airfield networks should be reviewed, revised, and approved by the Stapleton Task Force prior to the performance of delay experiment model runs.

Sincerely,

Stephen L. M. Hockaday
Manager

SLMH/nbe
Enclosure

cc: Mr. J. R. Dupree (ALG-312)
Mr. F. Jaeger (ARM-4)

ATTACHMENT 1

STAGE 1 EXPERIMENTS

Experiment Number	Model	Arrival Runways	Departure Runways	Weather	Demand	ATC Scenario	Near-Term Improvements
1	ASM[a]	17L-17R-26L	17L-17R	VFR1	1978	1978	1978 - Baseline 1978
2	ASM	25-26L-26R	35L-35R	VFR1	1978	1978	1978 - Baseline 1978
3	ASM	26L	35L-35R	IFR1	1978	1978	1978 - Baseline 1978
4	ASM	8L-17L-17R	7-8L-8R	VFR1	1978	1978	1978 - Baseline 1978
5	ASM-S	8L-17L-17R	7-8L-17L-17R	VFR1	1978	1978	Closure of Runway 8R/26L
6	ASM-S	25-26R	35L-35R	VFR1	1978	1978	Closure of Runway 8R/26L
7 *	ASM-S	17L-17R	17L-17R	VFR1	1978	1978	Closure of Runway 8R/26L
8	ASM-S	25-26L-26R	35L-35R	VFR1	1978	1978	Metering Rate = 60/hr-Runway 26R equal 26L in length
9	ASM	25-26L-26R	35L-35R	VFR1	1985	1985	1985 - Baseline 1985
10	ASM	26L	35L-35R	IFR1	1985	1985	1985 - Baseline 1985
11	ASM	26L	35L-35R	IFR1	1985	1985	Reduce Air Carrier Demand by 10%
12	ASM-S	25-26L-26R	35L-35R	VFR1	1985	1985	Reduce GA by 25%
13 *	ASM-S	25-26L-26R	35L-35R	VFR1	1985	1985	Reduce GA by 50%
14	ASM-S	25-26L-26R	35L-35R	VFR1	1985	1985	Reduce GA by 75%
15	ADM	N.A.	N.A.	N.A.	1978	1978	1978
16	ADM	N.A.	N.A.	N.A.	1985	1978	1985

Attachment

STAGE I EXPERIMENTS: INPUT DATA PACKAGE

STAPLETON INTERNATIONAL AIRPORT

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.

June 1978

INPUT DATA FOR EXPERIMENT NUMBER 1.

a. LOGISTICS

1. Title: Stapleton International Airport Airfield Simulation Model: Stage I Experiments

2. Random Number Seeds: 2017, 3069, 4235, 5873, 6981, 7137, 8099, 9355, 0123, 1985.

3. Start and Finish Times: 0830 to 2100

4. Print Options: Summary run for ten random number seeds.

5. Airline Names:

Name	Code
Rocky Mountain	RM
Aspen	AS
United	UA
Braniff	BN
Western	WA
Continental	CO
Trans World	TW
Ozark	OZ
Delta	DL
North Central	NC
Texas International	TI
Frontier	FL
Third Level Carriers	TL

6. Processing Options: First run to check model input. Other runs in COMPUTE mode.

7. Truncation Limits: ± 3 standard deviations.

8. Time Switch: Not applicable.

b. AIRFIELD PHYSICAL CHARACTERISTICS

9. Airfield Network: See separate drawing.

10. Number of Runways: 3

11. Runway Identification: 26L, 17L, 17R

12. Departure Runway End Links: 188, 101

13. Runway Crossing Links: 188

14. Exit Taxiway Location:

Runway	Taxiway	Link	Distance from Threshold (feet)
17L	Z-4	107	9,000
17L	Z-2	113	12,000
17R	L-4	480	8,000
17R	L-1	172	11,500
26L	C-6	353	5,400
	B-4	489	5,400

15. Holding Areas: Not applicable.

16. Airline Gates:

Airline	Airline Gate Area
Rocky Mountain	1
Aspen	1
United	2,3
Braniff	2
Western	3
Continental	3,4
Trans World	4
Ozark	4
Delta	4
North Central	5
Texas International	5
Frontier	5
Third Level Carrier	1

17. General Aviation Basing Areas:

Name	Base Area Code
Combs Aviation	GC
Beechcraft Aviation	GB
Atlas Aviation	GA

c. ATC PROCEDURES

18. Aircraft Separations:

Arrival-Arrival Separation (n.m.)

		Trail Aircraft Class			
		A	B	C	D
Lead Aircraft Class	A	1.4	2.3	3.0	3.0
	B	1.4	2.4	3.2	3.4
	C	1.9	3.0	3.6	3.6
	D	3.7	5.1	4.5	4.1

Departure-Departure Separations (Seconds)

		Trail Aircraft Class			
		A	B	C	D
Lead Aircraft Class	A	45	45	55	55
	B	50	50	60	60
	C	50	60	60	60
	D	120	120	120	90

19. Route Data: See Figure 1.

20. Two-Way Path Data:

Two-way taxiways are located as follows:
1. Taxiway C3
2. Taxiway C4

21. Common Approach Paths:

Arrival Runway	Aircraft Class	Length of Common Approach Path
26L	A	1.0
	B	3.0
17L	A	1.0
	B	5.5
	C	5.5
	D	5.5
17R	A	1.0
	B	3.0
	C	5.5
	D	5.5

22. Vectoring Delays:

This input normally allocates delays among vectoring and holding. With profile descent at Stapleton, holding occurs rarely, if ever.

Model input values will be used that preclude holding for arrival aircraft.

23. Departure Runway Queue Control:

Departure runway assignments will be made to balance departure queues where appropriate.

24. Gate Hold Control:

Hold aircraft at gate when departure queue at runway is 10 or more.

25. Departure Airspace Constraints:

Aircraft are not held at gate due to departure airspace constraints. Flow control constraints from other Centers do not normally occur.

26. Inter-Arrival Gap:

With this runway use, arrival aircraft are delayed in the arrival airspace when departure delays exceed 10 minutes.

27. Runway Crossing Delay Control:

Arrival and departure runway operations are only interrupted for a taxiing aircraft to cross an active runway when the taxiing aircraft is delayed by 5 minutes or more.

d. AIRCRAFT OPERATIONAL CHARACTERISTICS

28. Exit Taxiway Utilization:

Exit Utilization (Percent)

	A/C Class	B-4	B-2
Runway 17L	A	100	
	B	100	
	C	90	10
	D	90	10

	A/C Class	L-4	L-1
Runway 17R	A	100	
	B	100	
	C	80	20
	D	80	20

	A/C Class	C-6 B-4
Runway 26L	A	100
	B	100

29. Arrival Runway Occupancy Times:

Runway Occupany Time (Seconds)

	A/C Class	B-4	B-2
Runway 17L	A	80	
	B	75	
	C	65	80
	D	65	80

	A/C Class	L-4	L-1
Runway 17R	A	80	
	B	75	
	C	65	80
	D	65	80

	A/C Class	C-6 B-4
Runway 26L	A	60
	B	55

30. Touch & Go Occupancy Times:

Aircraft Class	Runway Occupancy Time (Seconds) Mean	Standard Deviation
A	22	3
B	23	3
C	27	4
D	27	4

31. Departure Runway Occupancy Times:

Aircraft Class	Runway Occupancy Time (Seconds) Mean	Standard Deviation
A	23	3
B	26	3
C	37	4
D	37	4

32. Taxi Speeds: 5-30 mph depending on location.

33. Approach Speeds:

Aircraft Class	Approach Speed (Knots) Mean	Standard Deviation
A	100	10
B	135	10
C	155	10
D	160	10

34. Gate Service Times: Not applicable.

35. Airspace Travel Times: See Table 1.

36. Runway Crossing Times:

Aircraft Class	Runway Crossing Time (Seconds)
A	12
B	14
C	17
D	20

37. Lateness Distribution: See Table 2.

38. Demand: See Table 3.

Table 1

AIRSPACE TRAVEL TIMES[a]
(minutes)
Stapleton International Airport
Stage I Experiments: Input Data

Fisc	Aircraft Class	Travel time to runways			
		8L/8R	17L/17R	26L/26R	25L/35R
KIOWA	1, 2	15	16	12	12
	3	18	19	14	14
	4	25	26	20	20
KEANN	1, 2	16	13	12	17
	3	19	15	14	20
	4	26	21	20	28
DRAKO	1, 2	14	11	16	17
	3	16	13	18	20
	4	23	19	26	28
BYSON	1, 2	13	16	16	13
	3	15	19	19	15
	4	21	27	27	21
"Pop-ups"	3	8	8	8	8
	4	9	9	9	9

a. Nominal (undelayed) travel times.

Table 2

ARRIVAL AIRCRAFT LATENESS DISTRIBUTION
(Average deviation from schedule, excluding delays due to destination airport)

Amount of time late or early	Percent of flights late or early (%)
More than 15 min. early	0
less than 15 min. early	5
On time	24
less than 5 minutes late	29
5 to 10 minutes late	15
10 to 15 minutes late	9
15 to 30 minutes late	9
30 to 45 minutes late	4
45 to 60 minutes late	2
more than 60 minutes late	3

Source: Peat, Marwick, Mitchell & Co., analysis of data provided by Stapleton Task Force.

Table 3

AIRCRAFT DEMAND: EXPERIMENT NUMBER 1
Stapleton International Airport
Stage I Experiments: Input Data

	Scheduled		General aviation			Total
Time period	air carrier	commuter	turbo engine	multiengine piston	single-engine piston	aircraft operations
0600-0700	15	3	4	4	4	31
0700-0800	37	9	8	12	11	77
0800-0900	45	11	10	14	14	94
0900-1000	57	14	13	18	17	119
1000-1100	55	13	12	17	17	114
1100-1200	50	12	11	16	15	104
1200-1300	63	15	14	20	19	131
1300-1400	48	12	11	15	14	100
1400-1500	59	14	13	18	18	122
1500-1600	43	10	10	13	13	89
1600-1700	48	12	11	15	14	100
1700-1800	48	12	11	16	15	104
1800-1900	53	13	12	16	16	110
1900-2000	46	11	11	14	14	96
2000-2100	33	8	8	10	10	69
2100-2200	33	7	8	10	10	69
	735	178	167	228	221	1529

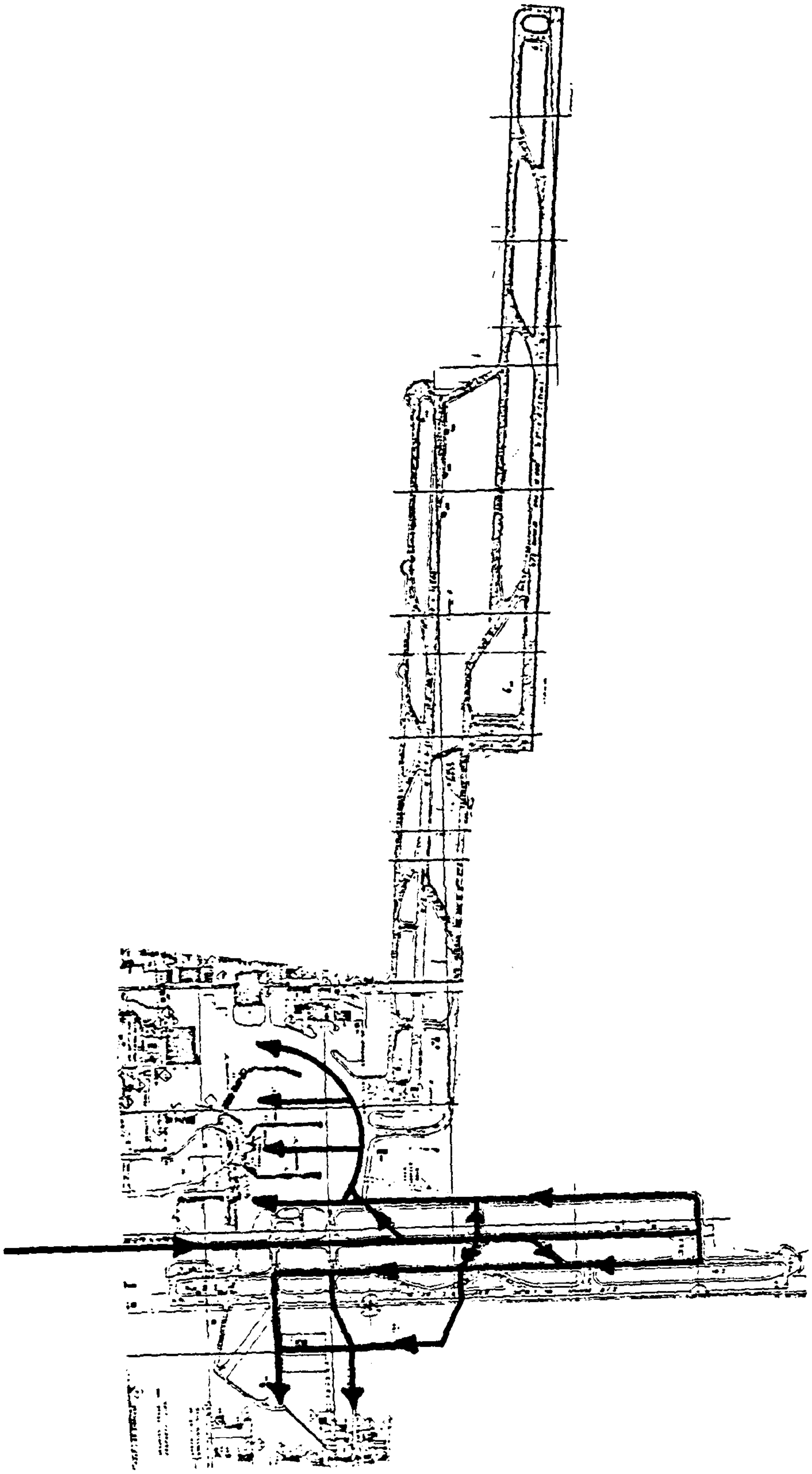


Figure 1
TAXIWAY ROUTES:
ARRIVALS ON RUNWAY 8L

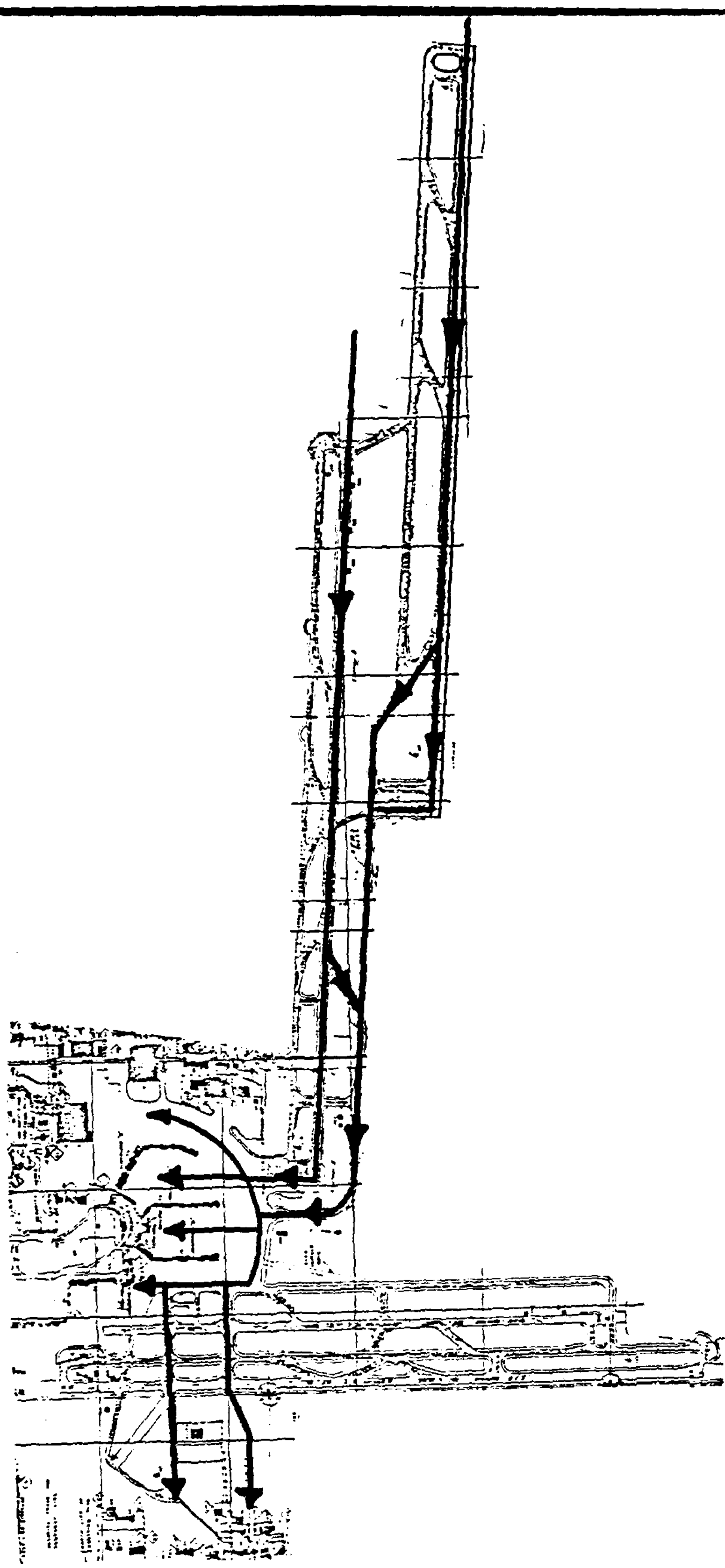


Figure 1 cont.
TAXIWAY ROUTES
ARRIVALS ON RUNWAYS 17L & 17R

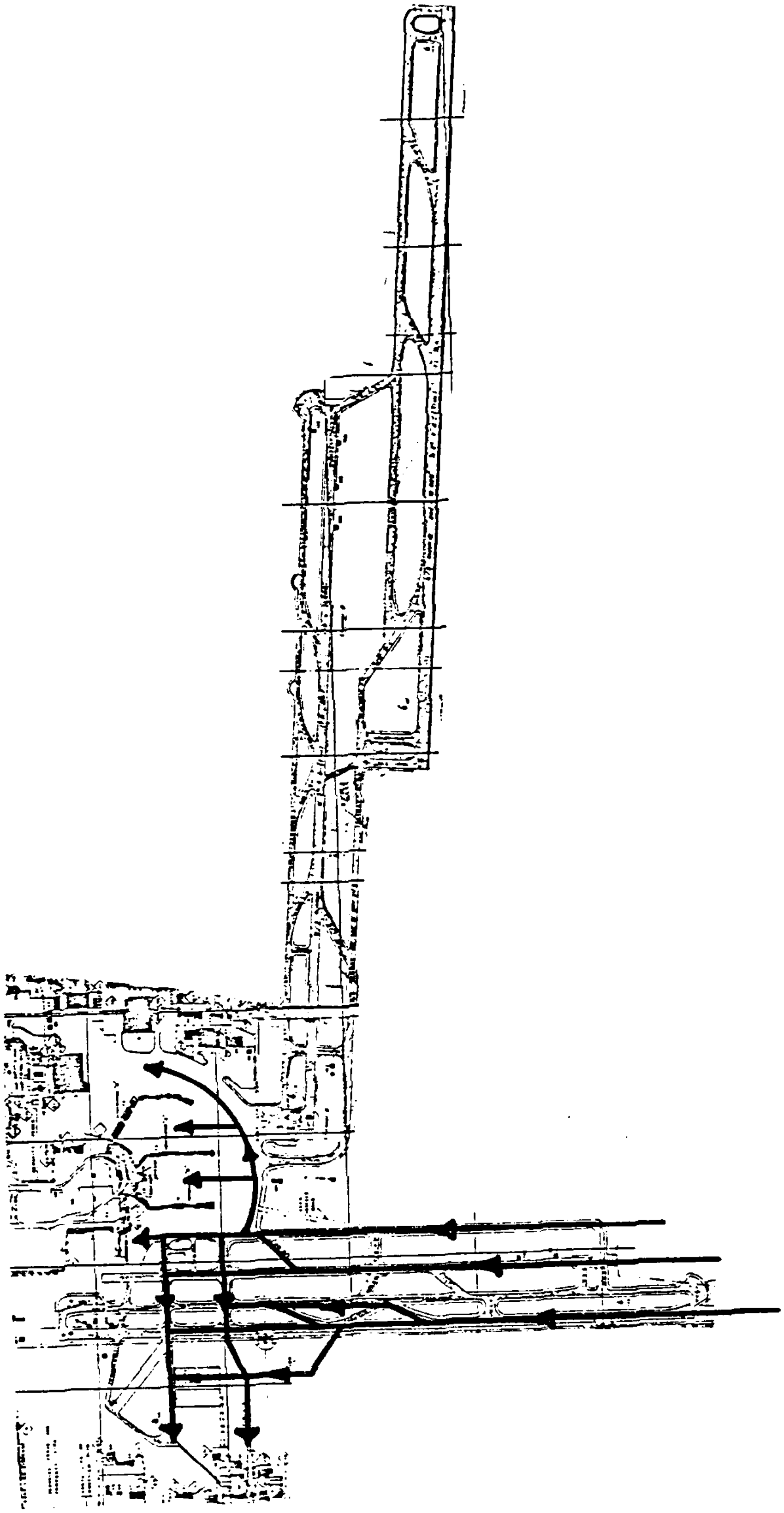


Figure 1 cont.
TAXIWAY ROUTES:
ARRIVALS ON RUNWAYS 25, 26L & 26R

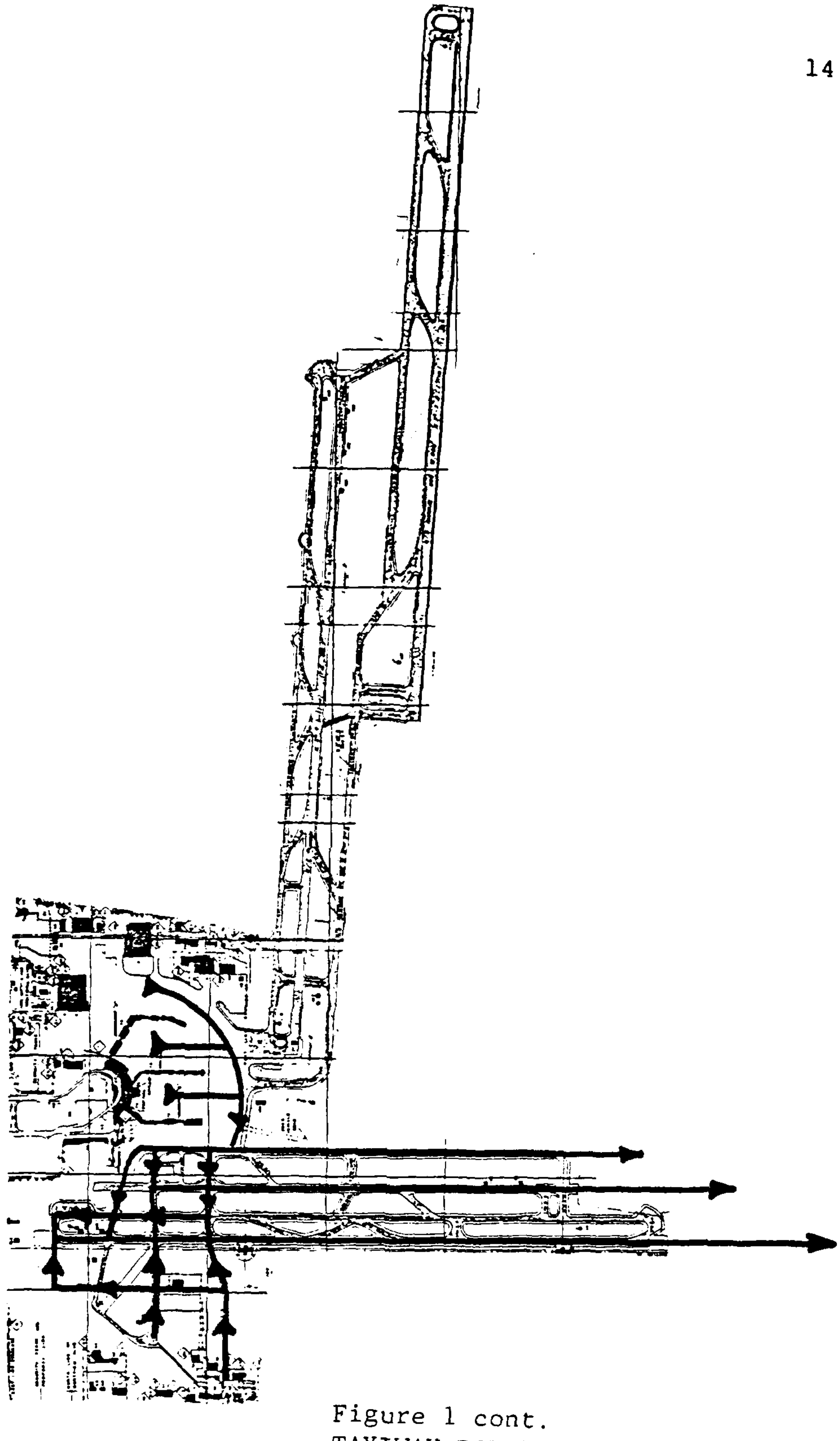


Figure 1 cont.
TAXIWAY ROUTES:
DEPARTURES ON RUNWAYS 7, 8L & 8R

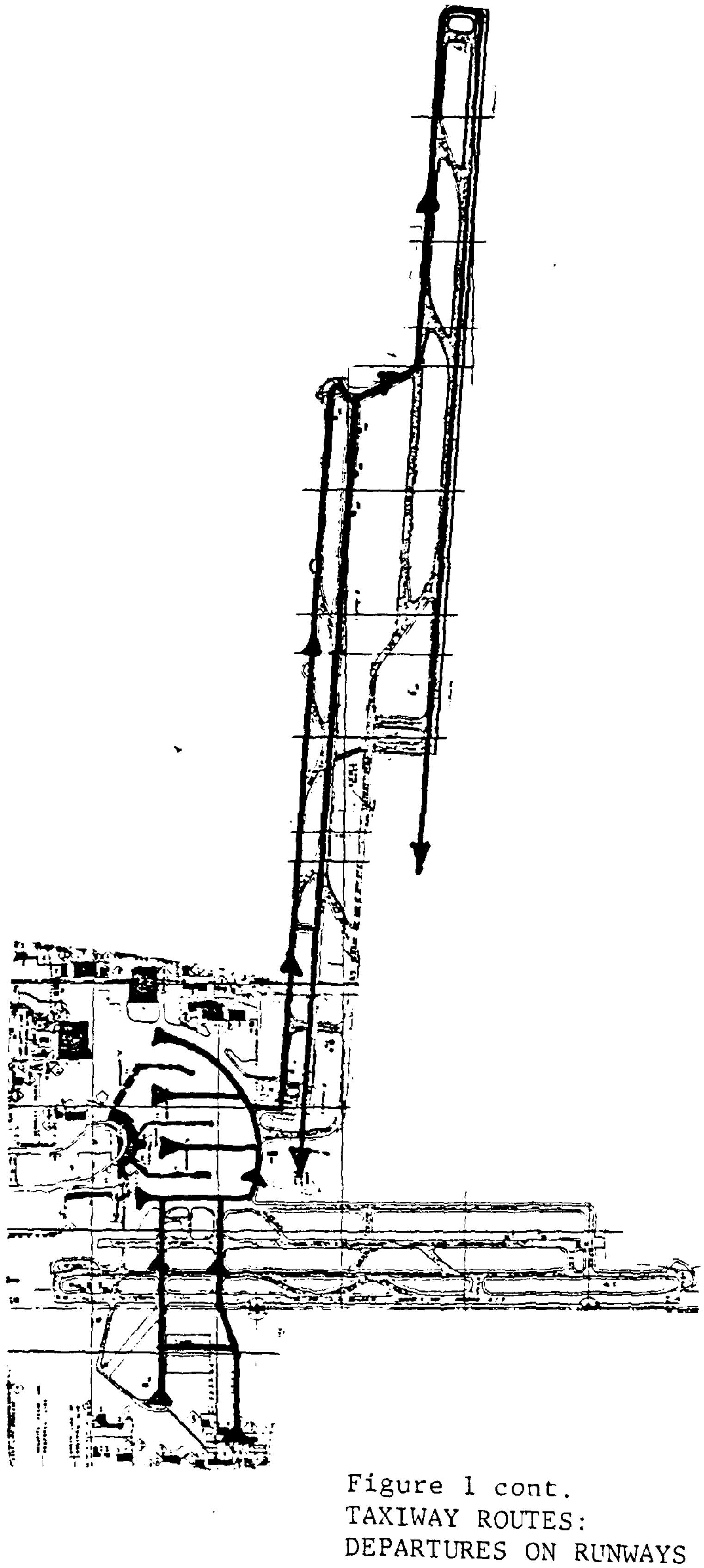


Figure 1 cont.
TAXIWAY ROUTES:
DEPARTURES ON RUNWAYS 17L & 17R

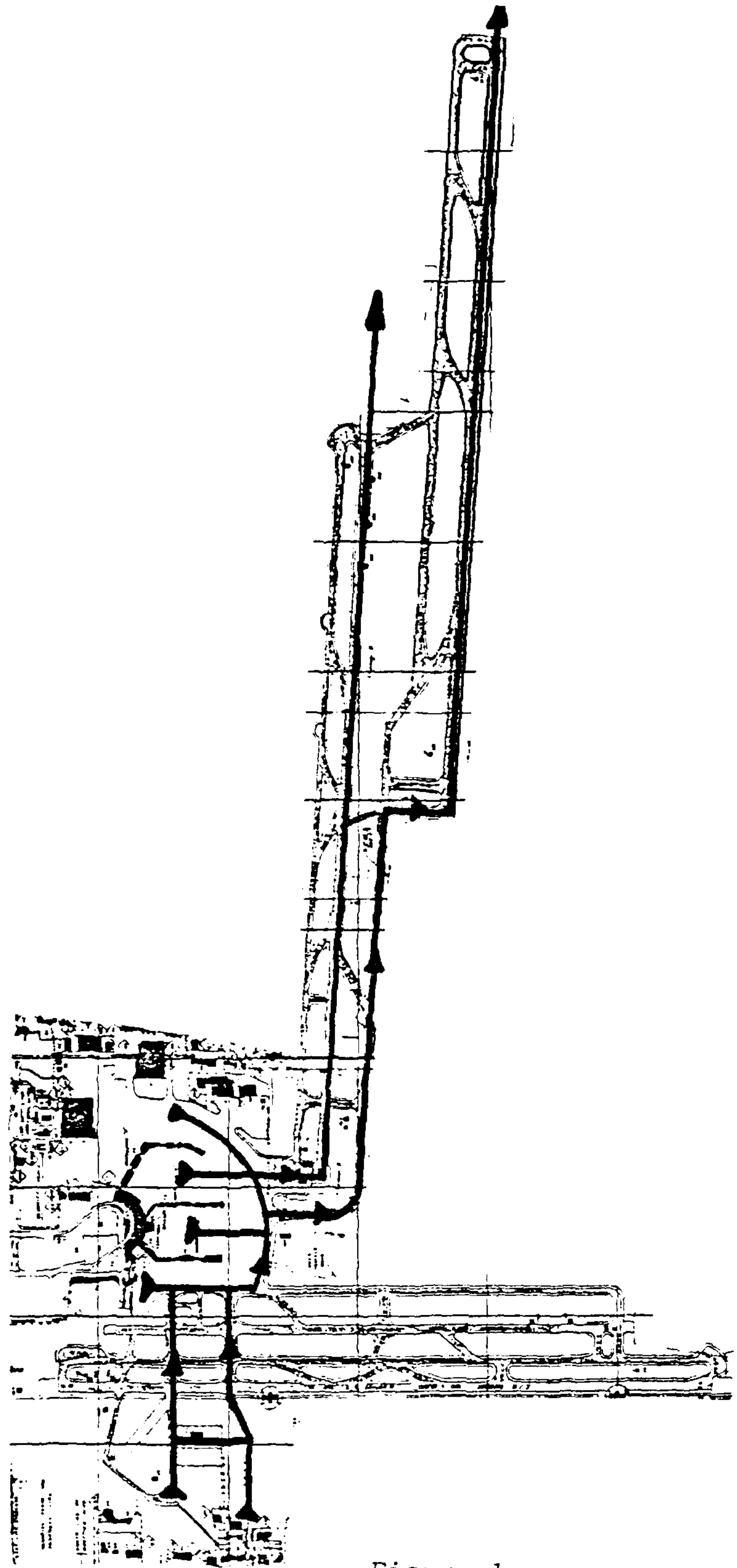


Figure 1 cont.
TAXIWAY ROUTES:
DEPARTURES ON RUNWAYS 35L & 35R

Experiment Number: 7 (Input changes from experiment number 1)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway and links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Arrival demand on [illegible]

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TASK FORCE DELAY STUDY. DENVER STAPLETON INTERNATIONAL AIRPORT,--ETC(U)
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2 OF 4
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INPUT DATA FOR EXPERIMENT NUMBER 2.

a. LOGISTICS

1. Title: Stapleton International Airport Airfield Simulation Model: Stage I Experiments

2. Random Number Seeds: 2017, 3069, 4235, 5873, 6981, 7137, 8099, 9355, 0123, 1985.

3. Start and Finish Times: 0830 to 2100

4. Print Options: Summary run for ten random number seeds.

5. Airline Names:

Name	Code
Rocky Mountain	RM
Aspen	AS
United	UA
Braniff	BN
Western	WA
Continental	CO
Trans World	TW
Ozark	OZ
Delta	DL
North Central	NC
Texas International	TI
Frontier	FL
Third Level Carriers	TL

6. Processing Options: First run to check model input. Other runs in COMPUTE mode.

7. Truncation Limits: ± 3 standard deviations.

8. Time Switch: Not applicable.

b. AIRFIELD PHYSICAL CHARACTERISTICS

9. Airfield Network: See separate drawing.

10. Number of Runways: 5

11. Runway Identification: 26L, 26R, 35L, 35R, 25

12. Departure Runway End Links: 183, 113

13. Runway Crossing Links: 352, 346, 345, 344, 395,
400, 357, 356, 318, 321.

14. Exit Taxiway Location:

Runway	Taxiway	Link	Distance from Threshold (feet)
26L	B-4,C-6	489,353	5,800
	C-5	354	6,100
	C-4	356	7,400
	C-3	357	8,400
26R	D-2	318	5,000
	C-4	316	6,000
	C-3	311	6,900
	End	310	7,400
25	D-3	322	3,400

15. Holding Areas: Not applicable.

16. Airline Gates:

Airline	Airline Gate Area
Rocky Mountain	1
Aspen	1
United	2,3
Braniff	2
Western	3
Continental	3,4
Trans World	4
Ozark	4
Delta	4
North Central	5
Texas International	5
Frontier	5
Third Level Carrier	1

17. General Aviation Basing Areas:

Name	Base Area Code
Combs Aviation	GC
Beechcraft Aviation	GB
Atlas Aviation	GA

c. ATC PROCEDURES

18. Aircraft Separations:

Arrival-Arrival Separation (n.m.)

		Trail Aircraft Class			
		A	B	C	D
Lead	A	1.4	2.3	3.0	3.0
Aircraft	B	1.4	2.4	3.2	3.4
Class	C	1.9	3.0	3.6	3.6
	D	3.7	5.1	4.5	4.1

		Trail Aircraft Class			
		A	B	C	D
Lead	A	45	45	55	55
Aircraft	B	50	50	60	60
Class	C	50	60	60	60
	D	120	120	120	90

19. Route Data: See Figure 1.

20. Two-Way Path Data:

Two-way taxiways are located as follows:
1. Taxiway C3
2. Taxiway C4
3. Apron Taxiway to south of Concourse B

21. Common Approach Paths:

Arrival Runway	Aircraft Class	Length of Common Approach Path
25	A	1.0
26R	A	3.0
	B	3.0
	C	5.5
	D	5.5
26L	A	5.5
	B	5.5
	C	5.5
	D	5.5

22. Vectoring Delays:

This input normally allocates delays among vectoring and holding. With profile descent at Stapleton, holding occurs rarely, if ever.

Model input values will be used that preclude holding for arrival aircraft.

23. Departure Runway Queue Control:

Departure runway assignments will be made to balance departure queues where appropriate.

24. Gate Hold Control:

Hold aircraft at gate when departure queue at runway is 10 or more.

25. Departure Airspace Constraints:

Aircraft are not held at gate due to departure airspace constraints. Flow control constraints from other Centers do not normally occur.

26. Inter-Arrival Gap:

With this runway use, arrival aircraft are not delayed in the arrival airspace to release departures.

27. Runway Crossing Delay Control:

Arrival and departure runway operations are only interrupted for a taxiing aircraft to cross an active runway when the taxiing aircraft is delayed by 5 minutes or more.

d. AIRCRAFT OPERATIONAL CHARACTERISTICS

28. Exit Taxiway Utilization:

	Exit Utilization (Percent)				
	A/C Class	B-4 C-6	C-5	C-4	C-3
Runway 26L	A	100			
	B		54	15	31
	C		24	54	22
	D			50	50

	A/C Class	D-2	C-4	C-3	End
Runway 26R	A	100			
	B	44	17	39	
	C	32	47	21	
	D				100

	A/C Class	D-3
Runway 25	A	100
	B	100

29. Arrival Runway Occupancy Times:

	A/C Class	Runway Occupancy Time (Seconds) B-4 C-6	C-5	C-4	C-3
Runway 26L	A	60			
	B		45	60	70
	C		41	54	58
	D			51	60

	A/C Class	D-2	C-4	C-3	End
Runway 26R	A	55			
	B	36	49	61	
	C	31	47	55	
	D				60

	A/C Class	D-3
Runway 25R	A	45
	B	40

30. Touch & Go Occupancy Times:

Aircraft Class	Runway Occupancy Time (Seconds) Mean	Standard Deviation
A	22	3
B	23	3
C	27	4
D	27	4

31. Departure Runway Occupancy Times:

Aircraft Class	Runway Occupancy Time (seconds)	
	Mean	Standard Deviation
A	23	3
B	26	3
C	37	4
D	37	4

32. Taxi Speeds: 5-30 mph depending on location.

33. Approach Speeds:

Aircraft Class	Approach Speed (Knots)	
	Mean	Standard Deviation
A	100	10
B	135	10
C	155	10
D	160	10

34. Gate Service Times: Not applicable.

35. Airspace Travel Times: See Table 1.

36. Runway Crossing Times:

Aircraft Class	Runway Crossing Time (Seconds)
A	12
B	14
C	17
D	20

37. Lateness Distribution: See Table 2.

38. Demand: See Table 3.

Experiment Number: 3 (Input changes from experiment number 2)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway and links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	Use IFR separations
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Change arrival runway assignments-all arrivals on 26L.

Experiment Number: 3
Weather Condition: IFR-1

Arrival-Arrival Separation (n.m.)

		Trail Aircraft Class A	B	C	D
Lead Aircraft Class	A	3.0	3.0	3.3	3.5
	B	3.0	3.0	3.3	3.5
	C	4.5	4.5	3.3	3.3
	D	6.5	6.5	5.5	4.5

Departure-Departure Separations (seconds)

		Trail Aircraft Class A	B	C	D
Lead Aircraft Class	A	60	60	60	60
	B	60	60	60	60
	C	60	60	60	60
	D	120	120	120	90

Experiment Number: 6 (Input changes from experiment number 2)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Reassign arrivals on 26L to 26R and 25.

Experiment Number: 8 (Input changes from experiment number 2)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Amend to permit 60 arrivals per hour.

Experiment Number: 9 (Input changes from experiment number 2)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	Reflect 1985 airfield see network
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	~~Concourses E and F include~~
17 General aviation basing areas	all G/A to south side of 8-26
c. ATC Procedures	
18 Aircraft separations	1985 ATC scenario
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	1985 demand see Table 4

Table 4

AIRCRAFT DEMAND: EXPERIMENT NUMBER 9
Stapleton International Airport
Stage I Experiments: Input Data

	Scheduled		General aviation			
Time period	air carrier	commuter	turbo engine	multiengine piston	single-engine piston	Total aircraft operations
0600-0700		3	3	3	3	
0700-0800		7	7	8	7	
0800-0900		9	9	9	8	
0900-1000		11	11	12	11	
1000-1100	To be	11	11	12	10	
1100-1200	provided	10	10	10	9	
1200-1300	by Task	13	13	13	11	
1300-1400	Force	10	9	10	9	
1400-1500		12	11	12	11	
1500-1600		9	8	9	8	
1600-1700		10	9	10	9	
1700-1800		10	10	11	9	
1800-1900		11	10	11	10	
1900-2000		9	9	10	8	
2000-2100		7	7	7	6	
2100-2200		6	7	7	6	
		148	144	154	135	

Experiment Number: 12 (Input changes from experiment number 3)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	1985 Network
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	Concourses E and F
17 General aviation basing areas	all G/A on south side of 8-26
c. ATC Procedures	
18 Aircraft separations	1985 ATC Scenario
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	1985 Demand see Table 4

Experiment Number: 11 (Input changes from experiment number 10)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway and links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Reduce air carrier demand by 10%.

Experiment Number: 12 (Input changes from experiment number 9)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Reduce general aviation demand 25%.

Experiment Number: 13 (Input changes from experiment number 9)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Reduce general aviation demand 50%.

Experiment Number: 14 (Input changes from experiment number 9)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway and links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Reduce general aviation demand 75%.

INPUT DATA FOR EXPERIMENT NUMBER 4.

a. LOGISTICS

1. Title: Stapleton International Airport Airfield Simulation Model: Stage I Experiments

2. Random Number Seeds: 2017, 3069, 4235, 5873, 6981, 7137, 8099, 9355, 0123, 1985.

3. Start and Finish Times: 0830 to 2100

4. Print Options: Summary run for ten random number seeds.

5. Airline Names:

Name	Code
Rocky Mountain	RM
Aspen	AS
United	UA
Braniff	BN
Western	WA
Continental	CO
Trans World	TW
Ozark	OZ
Delta	DL
North Central	NC
Texas International	TI
Frontier	FL
Third Level Carriers	TL

6. Processing Options: First run to check model input. Other runs in COMPUTE mode.

7. Truncation Limits: ± 3 standard deviations.

8. Time Switch: Not applicable.

b. AIRFIELD PHYSICAL CHARACTERISTICS

9. Airfield Network: See separate drawing.

10. Number of Runways: 5

11. Runway Identification: 8L, 8R, 17L, 17R, 7

12. Departure Runway End Links: 311, 359, 487

13. Runway Crossing Links: 316, 356, 357, 395, 400

14. Exit Taxiway Location:

Runway	Taxiway	Link	Distance from Threshold (feet)
17L	S-4	107	9,000
17L	S-2	113	12,000
17R	L-4	480	8,000
17R	L-1	172	11,500
8L	D-2	318	2,000
8L	D-3	321/347	3,500
8L	D-5	323/349	6,700

15. Holding Areas: Not applicable.

16. Airline Gates:

Airline	Airline Gate Area
Rocky Mountain	1
Aspen	1
United	2,3
Braniff	2
Western	3
Continental	3,4
Trans World	4
Ozark	4
Delta	4
North Central	5
Texas International	5
Frontier	5
Third Level Carrier	1

17. General Aviation Basing Areas:

Name	Base Area Code
Combs Aviation	GC
Beechcraft Aviation	GB
Atlas Aviation	GA

c. ATC PROCEDURES

18. Aircraft Separations:

Arrival-Arrival Separation (n.m.)

		Trail Aircraft Class			
		A	B	C	D
Lead	A	1.4	2.3	3.0	3.0
Aircraft	B	1.4	2.4	3.2	3.4
Class	C	1.9	3.0	3.6	3.6
	D	3.7	5.1	4.5	4.1

Departure-Departure Separations (Seconds)

		Trail Aircraft Class			
		A	B	C	D
Lead	A	45	45	55	55
Aircraft	B	50	50	60	60
Class	C	50	60	60	60
	D	120	120	120	90

19. Route Data: See Figure 1.

20. Two-Way Path Data:

Two-way taxiways are located as follows:
1. Taxiway C3
2. Taxiway C4

21. Common Approach Paths:

Arrival Runway	Aircraft Class	Length of Common Approach Path
26L	A	1.0
	B	3.0
17L	A	1.0
	B	5.5
	C	5.5
	D	5.5
17R	A	1.0
	B	3.0
	C	5.5
	D	5.5

22. Vectoring Delays:

This input normally allocates delays among vectoring and holding. With profile descent at Stapleton, holding occurs rarely, if ever.

Model input values will be used that preclude holding for arrival aircraft.

23. Departure Runway Queue Control:

Departure runway assignments will be made to balance departure queues where appropriate.

24. Gate Hold Control:

Hold aircraft at gate when departure queue at runway is 10 or more.

25. Departure Airspace Constraints:

Aircraft are not held at gate due to departure airspace constraints. Flow control constraints from other Centers do not normally occur.

26. Inter-Arrival Gap:

With this runway use, arrival aircraft on 86 are delayed in the arrival airspace to release departures on 8L when the departure delays exceed 10 minutes.

27. Runway Crossing Delay Control:

Arrival and departure runway operations are only interrupted for a taxiing aircraft to cross an active runway when the taxiing aircraft is delayed by 5 minutes or more.

d. AIRCRAFT OPERATIONAL CHARACTERISTICS

28. Exit Taxiway Utilization:

Exit Utilization (Percent)

	A/C Class	S-4	S-2
Runway 17L	A	100	
	B	100	
	C	90	10
	D	90	10

	A/C Class	L-4	L-1
Runway 17R	A	100	
	B	100	
	C	80	20
	D	80	20

	A/C Class	C-6 B-4
Runway 26L	A	100
	B	100

29. Arrival Runway Occupancy Times:

Runway Occupany Time (Seconds)

	A/C Class	S-4	S-2
Runway 17L	A	80	
	B	75	
	C	65	80
	D	65	80

	A/C Class	L-4	L-1
Runway 17R	A	80	
	B	75	
	C	65	80
	D	65	80

	A/C Class	C-6 B-4
Runway 26L	A	60
	B	55

30. Touch & Go Occupancy Times:

Aircraft Class	Runway Occupancy Time (Seconds) Mean	Standard Deviation
A	22	3
B	23	3
C	27	4
D	27	4

31. Departure Runway Occupancy Times:

Aircraft Class	Runway Occupancy Time (Seconds) Mean	Standard Deviation
A	23	3
B	26	3
C	37	4
D	37	4

32. Taxi Speeds: 5-30 mph depending on location.

33. Approach Speeds:

Aircraft Class	Approach Speed (Knots) Mean	Standard Deviation
A	100	10
B	135	10
C	155	10
D	160	10

34. Gate Service Times: Not applicable.

35. Airspace Travel Times: See Table 1.

36. Runway Crossing Times:

Aircraft Class	Runway Crossing Time (Seconds)
A	12
B	14
C	17
D	20

37. Lateness Distribution: See Table 2.

38. Demand: See Table 3.

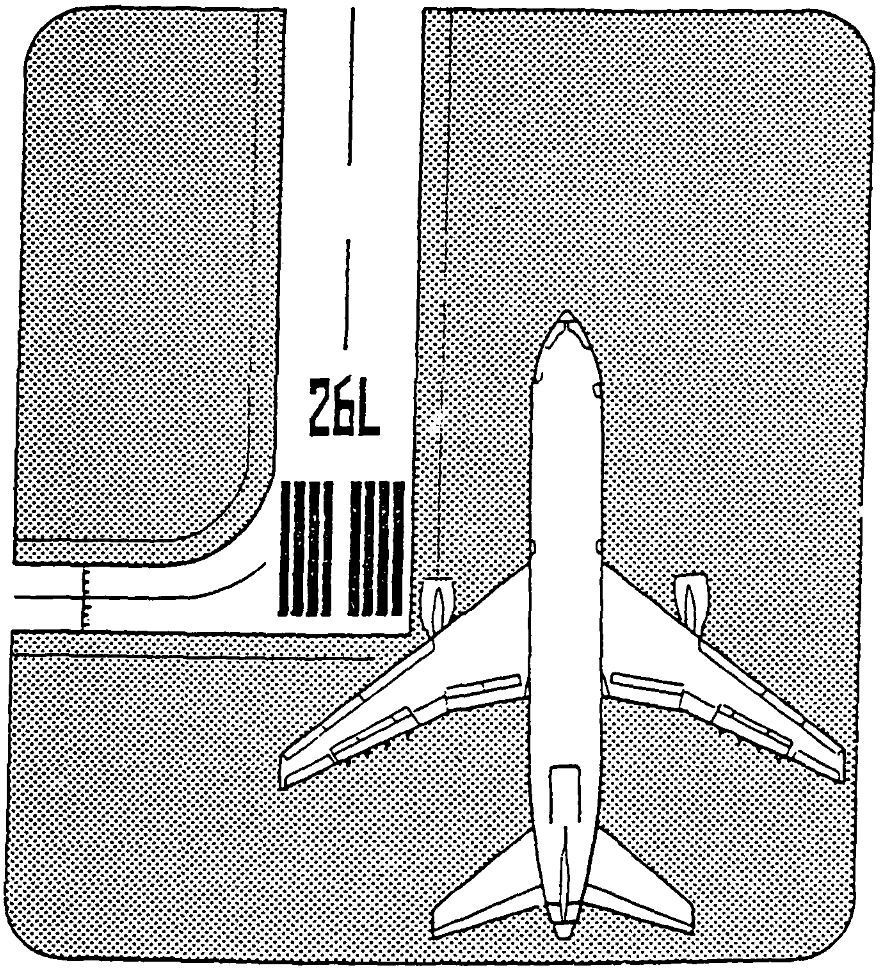
Experiment Number: 5 (Input changes from experiment number 4)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Reassign departures on 8R to 8L, 7, 17L and 17R.

STAPLETON INTERNATIONAL AIRPORT

DATA PACKAGE NO. 3

AIRPORT IMPROVEMENT TASK FORCE DELAY STUDIES



prepared for

DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

under contract

DOT FA77WA -3961

PMM&Co. Peat, Marwick, Mitchell & Co.

AUGUST 1978

PEAT, MARWICK, MITCHELL & CO.
P. O. BOX 8007
SAN FRANCISCO INTERNATIONAL AIRPORT
SAN FRANCISCO, CALIFORNIA 94128

Telephone: (415) 347-9521

August 3, 1978

Mr. Ray Fowler, AEM-100
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

Re: Input Data for Stapleton Delay Experiments

Dear Ray:

Enclosed is the input data package for Stapleton Stage I delay experiments. This data package should be reviewed by the Stapleton Task Force prior to the August 9, 1978 subgroup meeting so that approval of the input data can be obtained in that meeting.

Sincerely,

Stephen L. M. Hockaday
Manager

SLMH/sq
Enclosure

cc: Mr. J. R. Dupree (ALG-312)
Mr. F. Jaeger (ARM-4)

Attachment

STAGE I EXPERIMENTS: INPUT DATA PACKAGE

STAPLETON INTERNATIONAL AIRPORT

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.

August 1978

STAGE 1 EXPERIMENTS

Experiment Number	Model	Arrival Runways	Departure Runways	Weather	Demand	ATC Scenario	Near-Term Improvements
2	ASM	25-26L-26R	35L-35R	VFR1	1978	1978	1978 - Baseline 1978
4	ASM	17L-17R	7-8L-8R	VFR1	1985	1978	1985 - Baseline 1985
8	ASM	25-26L-26R	35L-35R	VFR1	1978	1978	Metering Rate = 60/hr- Runway 26R equal 26L in length
9	ASM	25-26L-26R	35L-35R	VFR1	1985	1985	1985 - Baseline 1985
10	ASM	26L	35L-35R	IFR1	1985	1985	1985 - Baseline 1985
11	ASM	26L	35L-35R	IFR1	1985	1985	Reduce Air Carrier Demand by 10%
13	ASM	25-26L-26R	35L-35R	VFR1	1985	1985	Reduce GA by 50%
50	ADM	N.A.	N.A.	N.A.	1978	1978	1978
15	ASM	35L-35R	35L-35R	IFR2	1985	1985	1985 - Baseline 1985
18	ASM	17L-17R	17L-17R	VFR1	1985	1985	1985 - Baseline 1985
29	ASM	17L-17R	7-8L-8R	VFR1	1985	1978	Ext. 26R East to equal 26L length
30	ASM	17L-17R	7-8L-8R	VFR1	1985	1978	Ext. Taxiway D-1 from D-2 to C-2
31	ASM	35R	35L	IFR2	1985	1985	ASDE
33	ASM	17L-17R	17L-17R	VFR1	1985	1985	High Speed Exit-Runway 17L

INPUT DATA FOR EXPERIMENT NUMBER 2.

a. LOGISTICS

1. Title: Stapleton International Airport Airfield Simulation Model: Stage I Experiments

2. Random Number Seeds: 2017, 3069, 4235, 5873, 6981, 7137, 8099, 9355, 0123, 1985.

3. Start and Finish Times: 0830 to 2100

4. Print Options: Summary run for ten random number seeds.

5. Airline Names:

Name	Code
Rocky Mountain	RM
Aspen	AS
United	UA
Braniff	BN
Western	WA
Continental	CO
Trans World	TW
Ozark	OZ
Delta	DL
North Central	NC
Texas International	TI
Frontier	FL
Third Level Carriers	TL

6. Processing Options: First run to check model input. Other runs in COMPUTE mode.

7. Truncation Limits: ±3 standard deviations.

8. Time Switch: Not applicable.

b. AIRFIELD PHYSICAL CHARACTERISTICS

9. Airfield Network: See separate drawing.

10. Number of Runways: 5

11. Runway Identification: 26L, 26R, 35L, 35R, 25

12. Departure Runway End Links: 183, 113

13. Runway Crossing Links: 352, 346, 345, 344, 395, 400, 357, 356, 318, 321.

14. Exit Taxiway Location:

Runway	Taxiway	Link	Distance from Threshold (feet)
26L	B-4,C-6	489,353	5,800
	C-5	354	6,100
	C-4	356	7,400
	C-3	357	8,400
26R	D-2	318	5,000
	C-4	316	6,000
	C-3	311	6,900
	End	310	7,400
25	D-3	322	3,400

15. Holding Areas: Not applicable.

16. Airline Gates:

Airline	Airline Gate Area
Rocky Mountain	1
Aspen	1
United	2,3
Braniff	2
Western	3
Continental	3,4
Trans World	4
Ozark	4
Delta	4
North Central	5
Texas International	5
Frontier	5
Third Level Carrier	1

17. General Aviation Basing Areas:

Name	Base Area Code
Combs Aviation	GC
Beechcraft Aviation	GB
Atlas Aviation	GA

c. ATC PROCEDURES

18. Aircraft Separations:

Arrival-Arrival Separation (n.m.)

		Trail Aircraft Class			
		A	B	C	D
Lead Aircraft Class	A	1.4	2.3	3.0	3.0
	B	1.4	2.4	3.2	3.4
	C	1.9	3.0	3.6	3.6
	D	3.7	5.1	4.5	4.1

		Trail Aircraft Class			
		A	B	C	D
Lead Aircraft Class	A	45.	45	55	55
	B	50	50	60	60
	C	50	60	60	60
	D	120	120	120	90

19. Route Data: See Figure 1.

20. Two-Way Path Data:

Two-way taxiways are located as follows:
1. Taxiway C3
2. Taxiway C4
3. Apron Taxiway to south of Concourse B

21. Common Approach Paths:

Arrival Runway	Aircraft Class	Length of Common Approach Path
25	A	1.0
26R	A	3.0
	B	3.0
	C	5.5
	D	5.5
26L	A	5.5
	B	5.5
	C	5.5
	D	5.5

22. Vectoring Delays:

This input normally allocates delays among vectoring and holding. With profile descent at Stapleton, holding occurs rarely, if ever.

Model input values will be used that preclude holding for arrival aircraft.

23. Departure Runway Queue Control:

Departure runway assignments will be made to balance departure queues where appropriate.

24. Gate Hold Control:

Hold aircraft at gate when departure queue at runway is 10 or more.

25. Departure Airspace Constraints:

Aircraft are not held at gate due to departure airspace constraints. Flow control constraints from other Centers do not normally occur.

26. Inter-Arrival Gap:

With this runway use, arrival aircraft are not delayed in the arrival airspace to release departures.

27. Runway Crossing Delay Control:

Arrival and departure runway operations are only interrupted for a taxiing aircraft to cross an active runway when the taxiing aircraft is delayed by 5 minutes or more.

d. AIRCRAFT OPERATIONAL CHARACTERISTICS

28. Exit Taxiway Utilization:

		Exit Utilization (Percent)			
	A/C Class	B-4 C-6	C-5	C-4	C-3
Runway 26L	A	100			
	B		54	15	31
	C		24	54	22
	D			50	50

	A/C Class	D-2	C-4	C-3	End
Runway 26R	A	100			
	B	44	17	39	
	C	32	47	21	
	D				100

	A/C Class	D-3
Runway 25	A	100
	B	100

29. Arrival Runway Occupancy Times:

	Runway Occupancy Time (Seconds)				
	A/C Class	B-4 C-6	C-5	C-4	C-3
Runway 26L	A	60			
	B		45	60	70
	C		41	54	58
	D			51	60

	A/C Class	D-2	C-4	C-3	End
Runway 26R	A	55			
	B	36	49	61	
	C	31	47	55	
	D				60

	A/C Class	D-3
Runway 25R	A	45
	B	40

30. Touch & Go Occupancy Times:

	Runway Occupancy Time (Seconds)	
Aircraft Class	Mean	Standard Deviation
A	22	3
B	23	3
C	27	4
D	27	4

31. Departure Runway Occupancy Times:

Aircraft Class	Runway Occupancy Time (seconds) Mean	Standard Deviation
A	23	3
B	26	3
C	37	4
D	37	4

32. Taxi Speeds: 5-30 mph depending on location.

33. Approach Speeds:

Aircraft Class	Approach Speed (Knots) Mean	Standard Deviation
A	100	10
B	135	10
C	155	10
D	160	10

34. Gate Service Times: Not applicable.

35. Airspace Travel Times: See Table 1.

36. Runway Crossing Times:

Aircraft Class	Runway Crossing Time (Seconds)
A	12
B	14
C	17
D	20

37. Lateness Distribution: See Table 2.

38. Demand: See Table 3.

Table 1

AIRSPACE TRAVEL TIMES[a]
(minutes)
Stapleton International Airport
Stage I Experiments: Input Data

Fisc	Aircraft Class	Travel time to runways 8L/8R	17L/17R	26L/26R	25L/35R
KIOWA	1, 2	15	16	12	12
	3	18	19	14	14
	4	25	26	20	20
KEANN	1, 2	16	13	12	17
	3	19	15	14	20
	4	26	21	20	28
DRAKO	1, 2	14	11	16	17
	3	16	13	18	20
	4	23	19	26	28
BYSON	1, 2	13	16	16	13
	3	15	19	19	15
	4	21	27	27	21
"Pop-ups"	3	8	8	8	8
	4	9	9	9	9

a. Nominal (undelayed) travel times.

Table 2

ARRIVAL AIRCRAFT LATENESS DISTRIBUTION
(Average deviation from schedule, excluding delays due to destination airport)

Amount of time late or early	Percent of flights late or early (%)
More than 15 min. early	0
less than 15 min. early	5
On time	24
less than 5 minutes late	29
5 to 10 minutes late	15
10 to 15 minutes late	9
15 to 30 minutes late	9
30 to 45 minutes late	4
45 to 60 minutes late	2
more than 60 minutes late	3

Source: Peat, Marwick, Mitchell & Co., analysis of data provided by Stapleton Task Force.

Table 3

AIRCRAFT DEMAND: EXPERIMENT NUMBER 1
Stapleton International Airport
Stage I Experiments: Input Data

	Scheduled		General aviation			Total
Time period	air carrier	commuter	turbo engine	multiengine piston	single-engine piston	aircraft operations
0600-0700	15	4	4	4	4	31
0700-0800	37	9	8	12	11	77
0800-0900	45	11	10	14	14	94
0900-1000	57	14	13	18	17	119
1000-1100	55	13	12	17	17	114
1100-1200	50	12	11	16	15	104
1200-1300	63	15	14	20	19	131
1300-1400	48	12	11	15	14	100
1400-1500	59	14	13	18	18	122
1500-1600	43	10	10	13	13	89
1600-1700	48	12	11	15	14	100
1700-1800	49	13	11	16	15	104
1800-1900	53	13	12	16	16	110
1900-2000	46	11	11	14	14	96
2000-2100	33	8	8	10	10	69
2100-2200	34	7	8	10	10	69
	735	178	167	228	221	1529

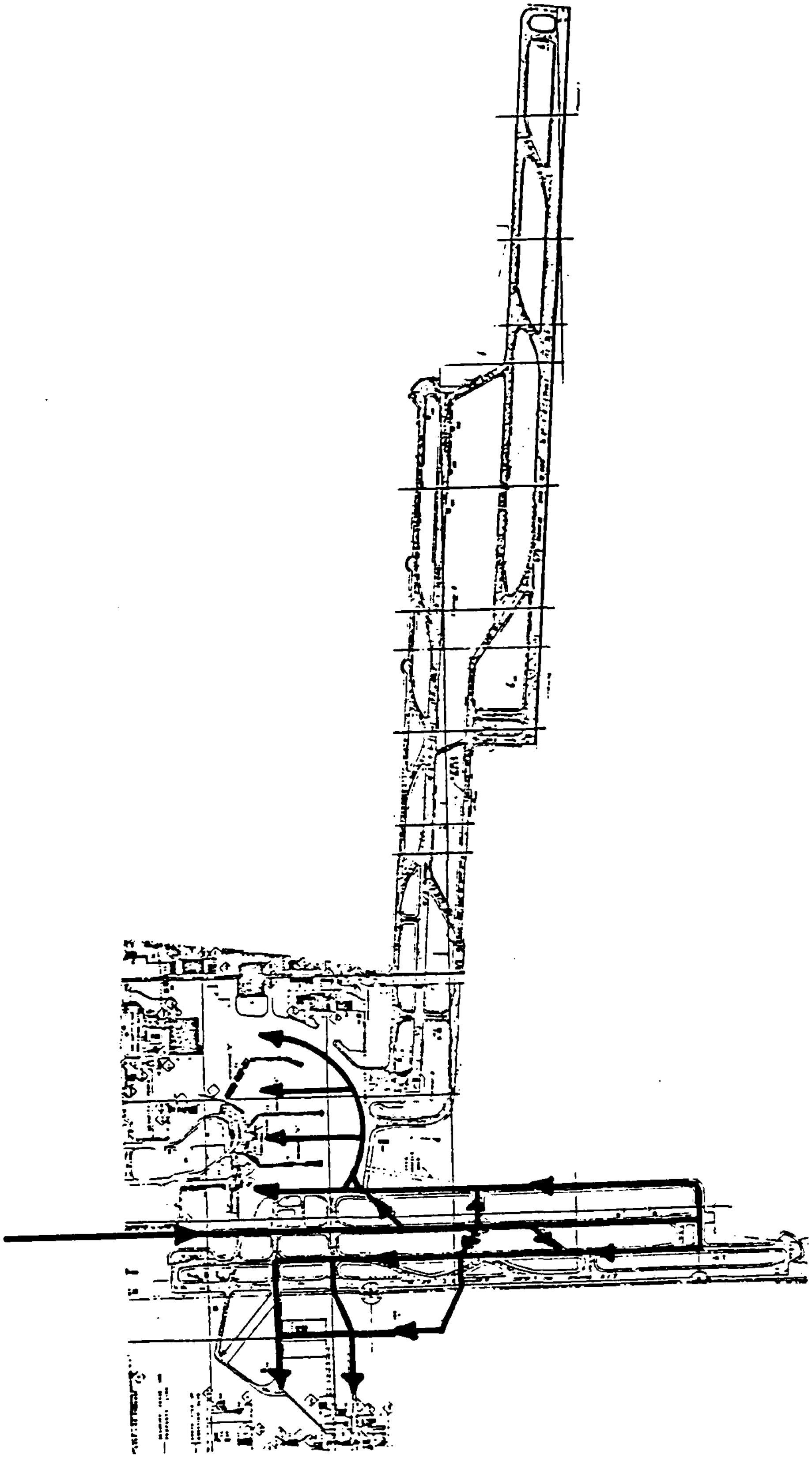


Figure 1
TAXIWAY ROUTES:
ARRIVALS ON RUNWAY 8L

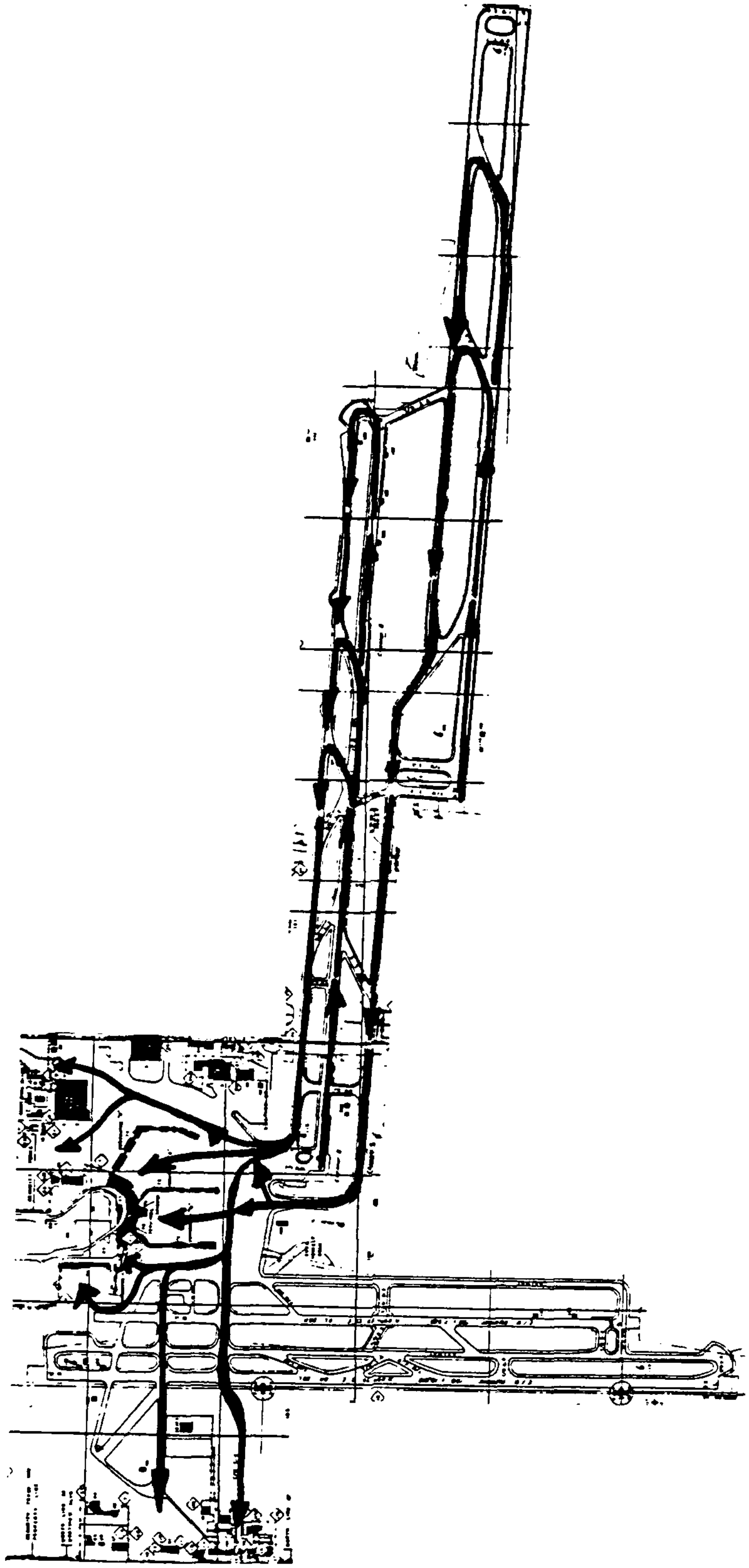


Figure 1 cont.
TAXIWAY ROUTES:
ARRIVALS ON RUNWAYS 35L & 35R

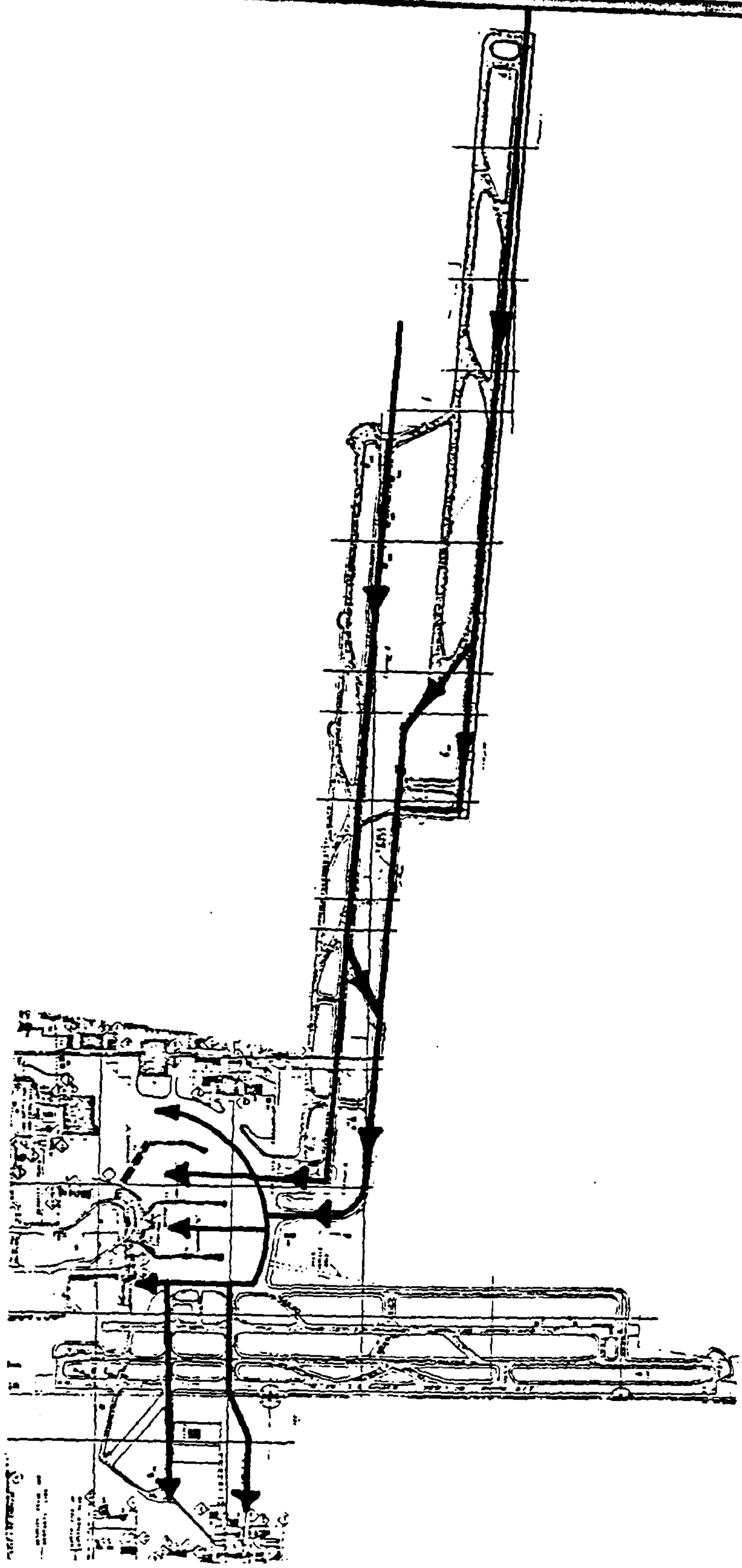


Figure 1 cont.
TAXIWAY ROUTES
ARRIVALS ON RUNWAYS 17L & 17R

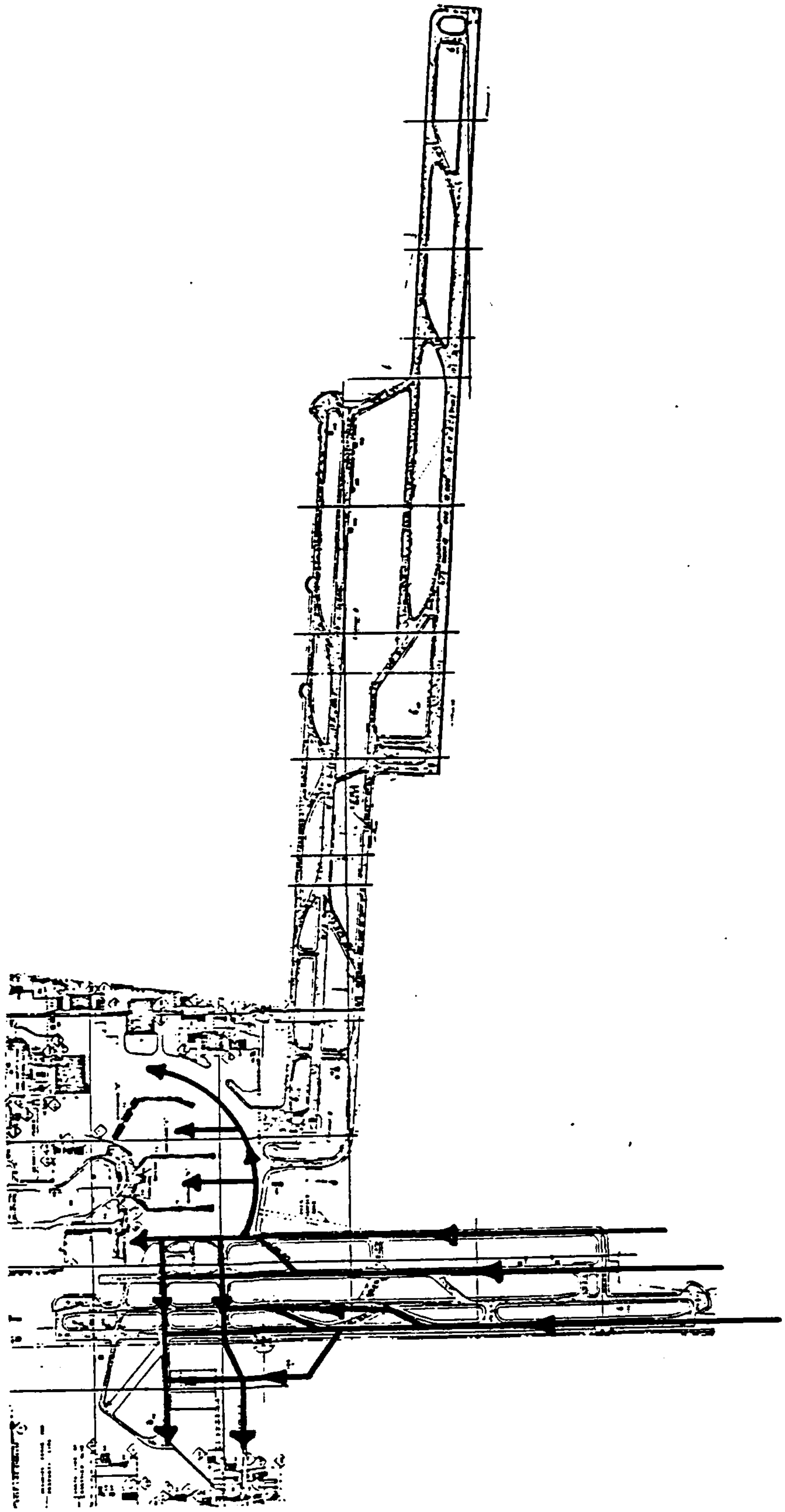


Figure 1 cont.
TAXIWAY ROUTES:
ARRIVALS ON RUNWAYS 25, 26L & 26R

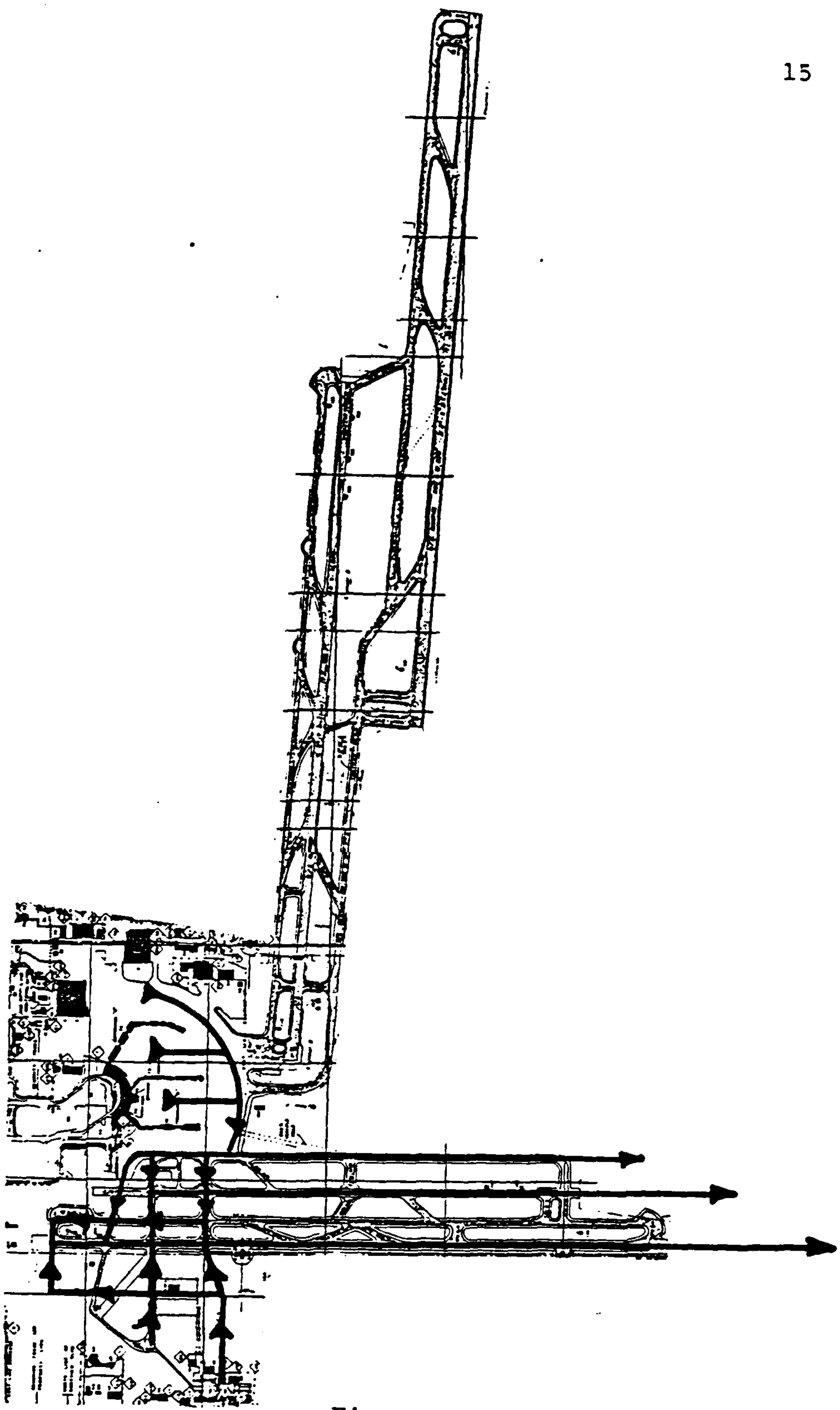


Figure 1 cont.
TAXIWAY ROUTES:
DEPARTURES ON RUNWAYS 7, 8L & 8R

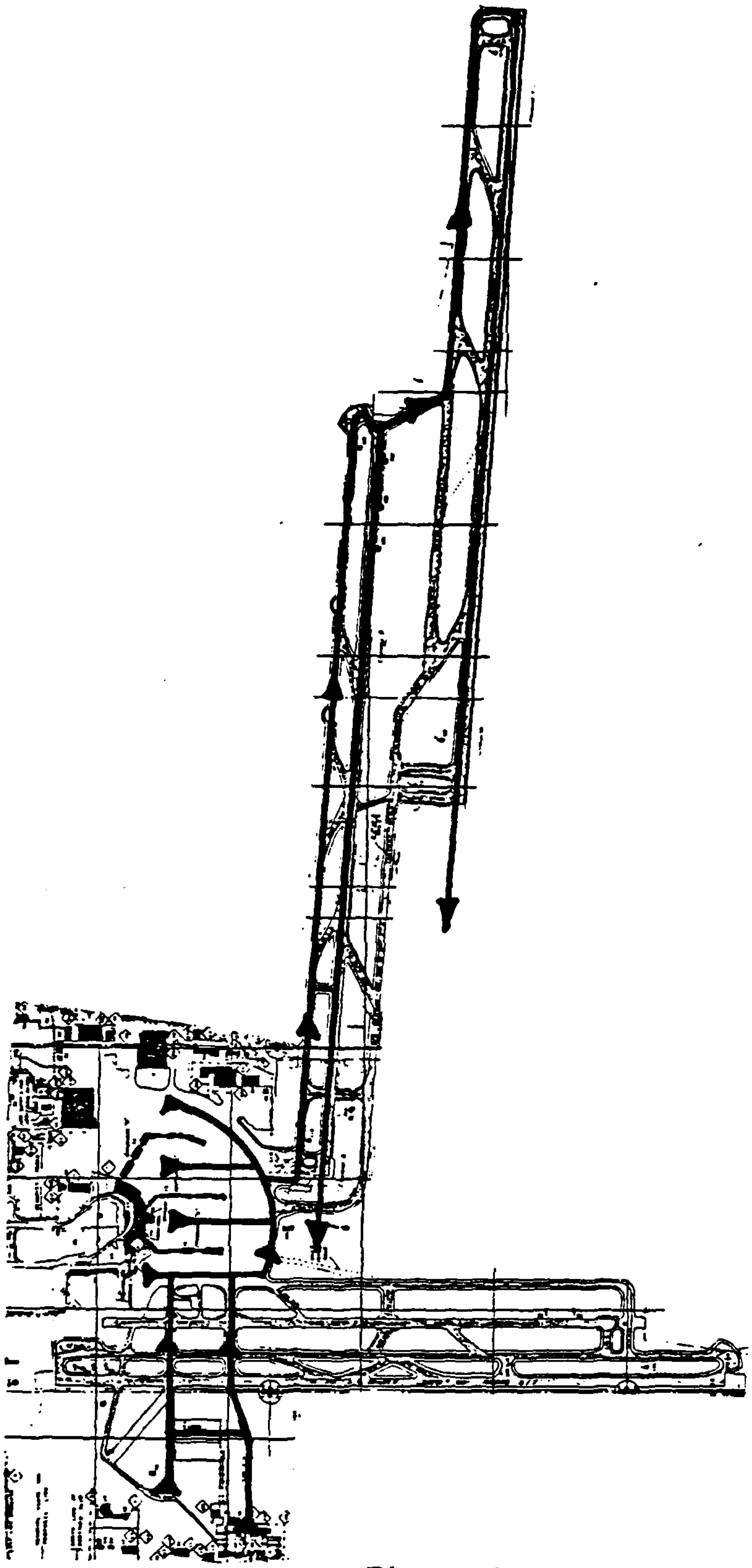


Figure 1 cont.
TAXIWAY ROUTES:
DEPARTURES ON RUNWAYS 17L & 17R

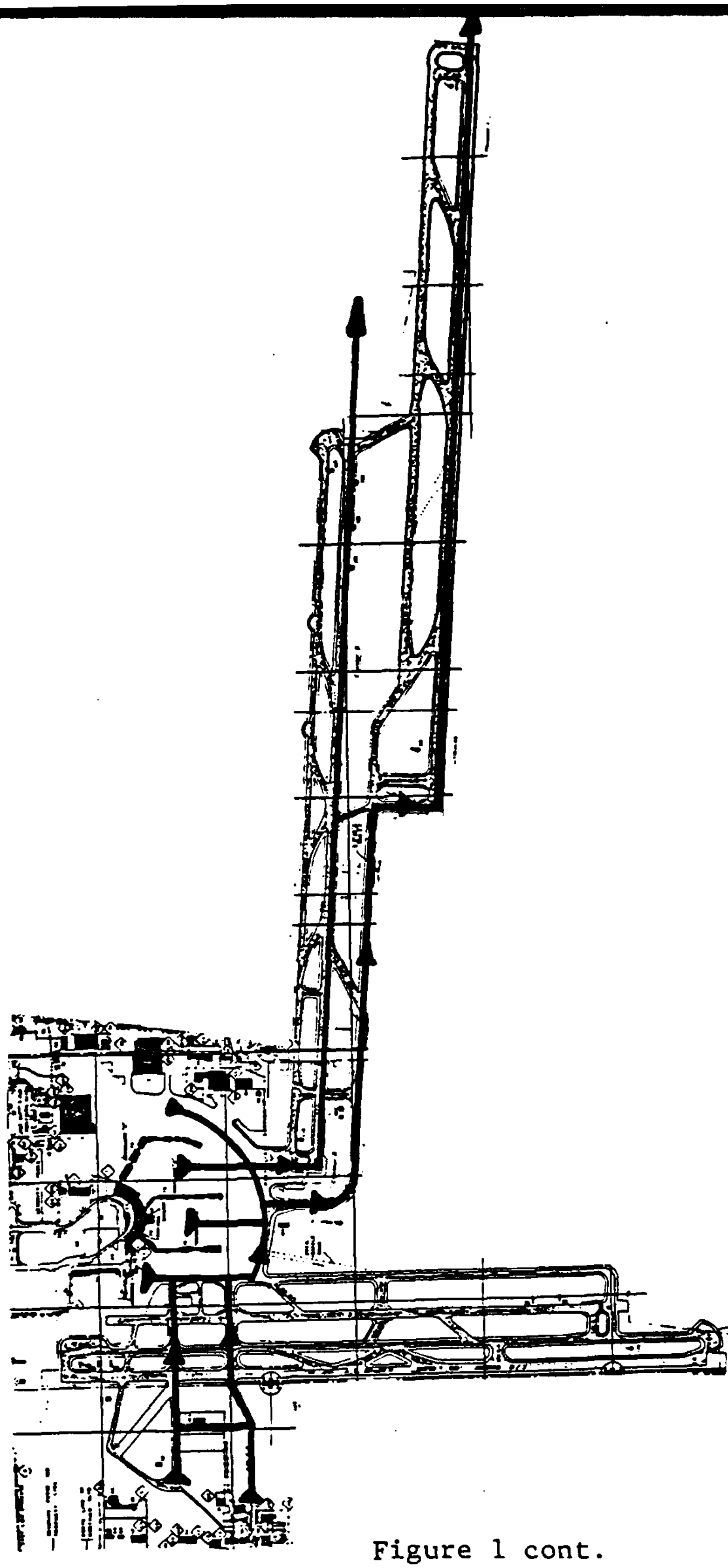


Figure 1 cont.
TAXIWAY ROUTES:
DEPARTURES ON RUNWAYS 35L & 35R

Experiment Number: 8 (Input changes from experiment number 2)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway and links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Amend to permit 60 arrivals per hour.

Experiment Number: 9 (Input changes from experiment number 2)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	Reflect 1985 airfield see network
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	~~Concourses E and F include~~
17 General aviation basing areas	all G/A to south side of 8-26
c. ATC Procedures	
18 Aircraft separations	1985 ATC scenario
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	1985 demand see Table 4

Experiment Number: 10 (Input changes from experiment number 9)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway and links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	Use IFR separations
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	All arrivals on Runway 26L

Experiment Number: 11 (Input changes from experiment number 10)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Reduce air carrier demand by 10%.

Experiment Number: 13 (Input changes from experiment number ___

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
A. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
B. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway and links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
C. ATC Procedures	
18 Aircraft separations	
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
D. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Reduce general aviation demand 50%

INPUT DATA FOR EXPERIMENT NUMBER 4.

a. LOGISTICS

1. Title: Stapleton International Airport Airfield Simulation Model: Stage I Experiments

2. Random Number Seeds: 2017, 3069, 4235, 5873, 6981, 7137, 8099, 9355, 0123, 1985.

3. Start and Finish Times: 0830 to 2100

4. Print Options: Summary run for ten random number seeds.

5. Airline Names:

Name	Code
Rocky Mountain	RM
Aspen	AS
United	UA
Braniff	BN
Western	WA
Continental	CO
Trans World	TW
Ozark	OZ
Delta	DL
North Central	NC
Texas International	TI
Frontier	FL
Third Level Carriers	TL

6. Processing Options: First run to check model input. Other runs in COMPUTE mode.

7. Truncation Limits: ±3 standard deviations.

8. Time Switch: Not applicable.

b. AIRFIELD PHYSICAL CHARACTERISTICS

9. Airfield Network: See separate drawing.

10. Number of Runways: 5

11. Runway Identification: 8L, 8R, 17L, 17R, 7

12. Departure Runway End Links: 311, 359, 487

13. Runway Crossing Links: 316, 356, 357, 395, 400.

14. Exit Taxiway Location:

Runway	Taxiway	Link	Distance from Threshold (feet)
17L	Z-4	107	9,000
17L	Z-2	113	12,000
17R	L-4	480	8,000
17R	L-1	172	11,500
8L	D-2	318	2,000
8L	D-3	321/347	3,500
8L	D-5	323/349	6,700

15. Holding Areas: Not applicable.

16. Airline Gates:

Airline	Airline Gate Area
Rocky Mountain	1
Aspen	1
United	2,3
Braniff	2
Western	3
Continental	3,4
Trans World	4
Ozark	4
Delta	4
North Central	5
Texas International	5
Frontier	5
Third Level Carrier	1

17. General Aviation Basing Areas:

Name	Base Area Code
Combs Aviation	GC
Beechcraft Aviation	GB
Atlas Aviation	GA

c. ATC PROCEDURES

18. Aircraft Separations:

Arrival-Arrival Separation (n.m.)

		Trail Aircraft Class			
		A	B	C	D
Lead Aircraft Class	A	1.4	2.3	3.0	3.0
	B	1.4	2.4	3.2	3.4
	C	1.9	3.0	3.6	3.6
	D	3.7	5.1	4.5	4.1

Departure-Departure Separations (Seconds)

		Trail Aircraft Class			
		A	B	C	D
Lead Aircraft Class	A	45	45	55	55
	B	50	50	60	60
	C	50	60	60	60
	D	120	120	120	90

19. Route Data: See Figure 1.

20. Two-Way Path Data:

Two-way taxiways are located as follows:
1. Taxiway C3
2. Taxiway C4

21. Common Approach Paths:

Arrival Runway	Aircraft Class	Length of Common Approach Path
17L	A	1.0
	B	5.5
	C	5.5
	D	5.5
17R	A	1.0
	B	3.0
	C	5.5
	D	5.5

22. Vectoring Delays:

This input normally allocates delays among vectoring and holding. With profile descent at Stapleton, holding occurs rarely, if ever.

Model input values will be used that preclude holding for arrival aircraft.

23. Departure Runway Queue Control:

Departure runway assignments will be made to balance departure queues where appropriate.

24. Gate Hold Control:

Hold aircraft at gate when departure queue at runway is 10 or more.

25. Departure Airspace Constraints:

Aircraft are not held at gate due to departure airspace constraints. Flow control constraints from other Centers do not normally occur.

26. Inter-Arrival Gap:

With this runway use, arrival aircraft on 86 are delayed in the arrival airspace to release departures on 8L when the departure delays exceed 10 minutes.

27. Runway Crossing Delay Control:

Arrival and departure runway operations are only interrupted for a taxiing aircraft to cross an active runway when the taxiing aircraft is delayed by 5 minutes or more.

d. AIRCRAFT OPERATIONAL CHARACTERISTICS

28. Exit Taxiway Utilization:

Exit Utilization (Percent)

	A/C Class	Ƶ-4	Ƶ-2
Runway 17L	A	100	
	B	100	
	C	90	10
	D	90	10

	A/C Class	L-4	L-1
Runway 17R	A	100	
	B	100	
	C	80	20
	D	80	20

29. Arrival Runway Occupancy Times:

Runway Occupany Time (Seconds)

	A/C Class	Ƶ-4	Ƶ-2
Runway 17L	A	47	
	B	50	
	C	65	80
	D	65	80

	A/C Class	L-4	L-1
Runway 17R	A	46	
	B	45	
	C	65	80
	D	65	80

30. Touch & Go Occupancy Times:

Aircraft Class	Runway Occupancy Time (Seconds)	
	Mean	Standard Deviation
A	22	3
B	23	3
C	27	4
D	27	4

31. Departure Runway Occupancy Times:

Aircraft Class	Runway Occupancy Time (Seconds)	
	Mean	Standard Deviation
A	23	3
B	26	3
C	37	4
D	37	4

32. Taxi Speeds: 5-30 mph depending on location.

33. Approach Speeds:

Aircraft Class	Approach Speed (Knots)	
	Mean	Standard Deviation
A	100	10
B	135	10
C	155	10
D	160	10

34. Gate Service Times: Not applicable.

35. Airspace Travel Times: See Table 1.

36. Runway Crossing Times:

Aircraft Class	Runway Crossing Time (Seconds)
A	12
B	14
C	17
D	20

37. Lateness Distribution: See Table 2.

38. Demand: See Table 4.

Table 4

AIRCRAFT DEMAND: EXPERIMENT NUMBER 4
Stapleton International Airport
Stage I Experiments: Input Data

	Scheduled		General aviation			Total
Time period	air carrier	commuter	turbo engine	multiengine piston	single-engine piston	aircraft operations
0600-0700	6	3	3	3	3	18
0700-0800	16	7	7	8	7	45
0800-0900	58	9	9	9	8	93
0900-1000	79	11	11	12	11	124
1000-1100	79	11	11	12	10	123
1100-1200	79	10	10	10	9	118
1200-1300	55	13	13	13	11	105
1300-1400	66	10	9	10	9	104
1400-1500	51	12	11	12	11	97
1500-1600	67	9	8	9	8	101
1600-1700	58	10	9	10	9	96
1700-1800	76	10	10	11	9	116
1800-1900	79	11	10	11	10	121
1900-2000	67	9	9	10	8	103
2000-2100	48	7	7	7	6	75
2100-2200	37	6	7	7	6	63
	921	148	144	154	135	1,502

Experiment Number: 29 (Input changes from experiment number 4)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	Ext. 26R East to equal 26L length
10 Number of runways	
11 Runway identification	
12 Departure runway and links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Reassign Air Carrier Departures to use both 8L and 8R

Experiment Number: 30 (Input changes from experiment number 4)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	Ext Taxiway D-1 from D-2 to C-2
10 Number of runways	
11 Runway identification	
12 Departure runway end links	Additional end link
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	
19 Route data	Additional Routes
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	

INPUT DATA FOR EXPERIMENT NUMBER 15.

a. LOGISTICS

1. Title: Stapleton International Airport Airfield Simulation Model: Stage I Experiments

2. Random Number Seeds: 2017, 3069, 4235, 5873, 6981, 7137, 8099, 9355, 0123, 1985.

3. Start and Finish Times: 0830 to 2100

4. Print Options: Summary run for ten random number seeds.

5. Airline Names:

Name	Code
Rocky Mountain	RM
Aspen	AS
United	UA
Braniff	BN
Western	WA
Continental	CO
Trans World	TW
Ozark	OZ
Delta	DL
North Central	NC
Texas International	TI
Frontier	FL
Third Level Carriers	TL

6. Processing Options: First run to check model input. Other runs in COMPUTE mode.

7. Truncation Limits: ± 3 standard deviations.

8. Time Switch: Not applicable.

b. AIRFIELD PHYSICAL CHARACTERISTICS

9. Airfield Network: See separate drawing.

10. Number of Runways: 2

11. Runway Identification: 35L, 35R

12. Departure Runway End Links: 183, 113

13. Runway Crossing Links: 187, 481

14. Exit Taxiway Location:

Runway	Taxiway	Link	Distance from Threshold (feet)
35R	S-6	104	9,000
35R	S-5	106	6,300
35L	L-9	188	11,500
35L	L-8	414	7,500
35L	L-7	177	6,000
35L	L-6	179	5,600

15. Holding Areas: Not applicable.

16. Airline Gates:

Airline	Airline Gate Area
Rocky Mountain	1
Aspen	1
United	2,3
Braniff	2
Western	3
Continental	3,4
Trans World	4
Ozark	4
Delta	4
North Central	5
Texas International	5
Frontier	5
Third Level Carrier	1

17. General Aviation Basing Areas:

Name	Base Area Code
Combs Aviation	GC
Beechcraft Aviation	GB
Atlas Aviation	GA

c. ATC PROCEDURES

18. Aircraft Separations:

Arrival-Arrival Separation (n.m.)

		Trail Aircraft Class			
		A	B	C	D
Lead	A	3	3	3	3
Aircraft	B	3	3	3	3
Class	C	3	3	3	3
	D	4	4	3	3

Departure-Departure Separations (Seconds)

		Trail Aircraft Class			
		A	B	C	D
Lead	A	60	60	60	60
Aircraft	B	60	60	60	60
Class	C	60	60	60	60
	D	120	120	120	90

19. Route Data: See Figure 1.

20. Two-Way Path Data:

Two-way taxiways are located as follows:
1. Taxiway C3
2. Taxiway C4

21. Common Approach Paths:

Arrival Runway	Aircraft Class	Length of Common Approach Path
35R	A	5.5
	B	5.5
	C	5.5
	D	5.5
35L	A	5.5
	B	5.5
	C	5.5
	D	5.5

22. Vectoring Delays:

This input normally allocates delays among vectoring and holding. With profile descent at Stapleton, holding occurs rarely, if ever.

Model input values will be used that preclude holding for arrival aircraft.

23. Departure Runway Queue Control:

Departure runway assignments will be made to balance departure queues where appropriate.

24. Gate Hold Control:

Hold aircraft at gate when departure queue at runway is 10 or more.

25. Departure Airspace Constraints:

Aircraft are not held at gate due to departure airspace constraints. Flow control constraints from other Centers do not normally occur.

26. Inter-Arrival Gap:

With this runway use, arrival aircraft are delayed in the arrival airspace when departure delays exceed 10 minutes.

27. Runway Crossing Delay Control:

Arrival and departure runway operations are only interrupted for a taxiing aircraft to cross an active runway when the taxiing aircraft is delayed by 5 minutes or more.

d. AIRCRAFT OPERATIONAL CHARACTERISTICS

28. Exit Taxiway Utilization:

Exit Utilization (Percent)

	A/C Class	Z-5	Z-6
Runway 35R	A	100	
	B	100	
	C	85	15
	D	80	20

	A/C Class	L-6	L-7	L-8	L-9
Runway 35L	A	100			
	B	100			
	C	15	75	10	
	D		85	10	5

29. Arrival Runway Occupancy Times:

Runway Occupany Time (Seconds)

	A/C Class	Z-5	Z-6
Runway 35R	A	60	
	B	65	
	C	68	88
	D	68	88

	A/C Class	L-6	L-7	L-8	L-9
Runway 35L	A	58			
	B	63			
	C	60	66	78	
	D		66	78	90

30. Touch & Go Occupancy Times:

Aircraft Class	Runway Occupancy Time (Seconds) Mean	Standard Deviation
A	22	3
B	23	3
C	27	4
D	27	4

31. Departure Runway Occupancy Times:

Aircraft Class	Runway Occupancy Time (Seconds) Mean	Standard Deviation
A	23	3
B	26	3
C	37	4
D	37	4

32. Taxi Speeds: 5-30 mph depending on location.

33. Approach Speeds:

Aircraft Class	Approach Speed (Knots) Mean	Standard Deviation
A	100	10
B	135	10
C	155	10
D	160	10

34. Gate Service Times: Not applicable.

35. Airspace Travel Times: See Table 1.

36. Runway Crossing Times:

Aircraft Class	Runway Crossing Time (Seconds)
A	12
B	14
C	17
D	20

37. Lateness Distribution: See Table 2.

38. Demand: See Table 4.

Experiment Number: 31 (Input changes from experiment number 15)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway and links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	Tighter Departure-Arrival Separation
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	Reflect ASDE
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	Reflect ASDE
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	All Arrivals on Runway 35R All Departures on Runway 35L

INPUT DATA FOR EXPERIMENT NUMBER 18.

a. LOGISTICS

1. Title: Stapleton International Airport Airfield Simulation Model: Stage I Experiments

2. Random Number Seeds: 2017, 3069, 4235, 5873, 6981, 7137, 8099, 9355, 0123, 1985.

3. Start and Finish Times: 0830 to 2100

4. Print Options: Summary run for ten random number seeds.

5. Airline Names:

Name	Code
Rocky Mountain	RM
Aspen	AS
United	UA
Braniff	BN
Western	WA
Continental	CO
Trans World	TW
Ozark	OZ
Delta	DL
North Central	NC
Texas International	TI
Frontier	FL
Third Level Carriers	TL

6. Processing Options: First run to check model input. Other runs in COMPUTE mode.

7. Truncation Limits: ±3 standard deviations.

8. Time Switch: Not applicable.

b. AIRFIELD PHYSICAL CHARACTERISTICS

9. Airfield Network: Ses separate drawing.

10. Number of Runways: 2

11. Runway Identification: 17L, 17R

12. Departure Runway End Links: 188, 101

13. Runway Crossing Links: 188

14. Exit Taxiway Location:

Runway	Taxiway	Link	Distance from Threshold (feet)
17L	Z-4	107	9,000
17L	Z-2	113	12,000
17R	L-4	480	8,000
17R	L-1	172	11,500

15. Holding Areas: Not applicable.

16. Airline Gates:

Airline	Airline Gate Area
Rocky Mountain	1
Aspen	1
United	2,3
Braniff	2
Western	3
Continental	3,4
Trans World	4
Ozark	4
Delta	4
North Central	5
Texas International	5
Frontier	5
Third Level Carrier	1

17. General Aviation Basing Areas:

Name	Base Area Code
Combs Aviation	GC
Beechcraft Aviation	GB
Atlas Aviation	GA

c. ATC PROCEDURES

18. Aircraft Separations:

Arrival-Arrival Separation (n.m.)

		Trail Aircraft Class A	B	C	D
Lead	A	1.9	1.9	1.9	1.9
Aircraft	B	1.9	1.9	1.9	1.9
Class	C	2.7	2.7	1.9	1.9
	D	4.0	4.0	3.0	2.7

Departure-Departure Separations (Seconds)

		Trail Aircraft Class A	B	C	D
Lead	A	35	35	45	50
Aircraft	B	35	35	45	50
Class	C	50	50	60	60
	D	120	120	120	90

19. Route Data: See Figure 1.

20. Two-Way Path Data:

Two-way taxiways are located as follows:
1. Taxiway C3
2. Taxiway C4

21. Common Approach Paths:

Arrival Runway	Aircraft Class	Length of Common Approach Path
17L	A	1.0
	B	5.5
	C	5.5
	D	5.5
17R	A	1.0
	B	3.0
	C	5.5
	D	5.5

22. Vectoring Delays:

This input normally allocates delays among vectoring and holding. With profile descent at Stapleton, holding occurs rarely, if ever.

Model input values will be used that preclude holding for arrival aircraft.

23. Departure Runway Queue Control:

Departure runway assignments will be made to balance departure queues where appropriate.

24. Gate Hold Control:

Hold aircraft at gate when departure queue at runway is 10 or more.

25. Departure Airspace Constraints:

Aircraft are not held at gate due to departure airspace constraints. Flow control constraints from other Centers do not normally occur.

26. Inter-Arrival Gap:

With this runway use, arrival aircraft are delayed in the arrival airspace when departure delays exceed 10 minutes.

27. Runway Crossing Delay Control:

Arrival and departure runway operations are only interrupted for a taxiing aircraft to cross an active runway when the taxiing aircraft is delayed by 5 minutes or more.

d. AIRCRAFT OPERATIONAL CHARACTERISTICS

28. Exit Taxiway Utilization:

	A/C Class	Exit Utilization (Percent) Z-4	Z-2
Runway 17L	A	100	
	B	100	
	C	90	10
	D	90	10

	A/C Class	L-4	L-1
Runway 17R	A	100	
	B	100	
	C	80	20
	D	80	20

29. Arrival Runway Occupancy Times:

	A/C Class	Runway Occupany Time (Seconds) Z-4	Z-2
Runway 17L	A	47	
	B	50	
	C	65	80
	D	65	80

	A/C Class	L-4	L-1
Runway 17R	A	46	
	B	45	
	C	65	80
	D	65	80

30. Touch & Go Occupancy Times:

Aircraft Class	Runway Occupancy Time (Seconds) Mean	Runway Occupancy Time (Seconds) Standard Deviation
A	22	3
B	23	3
C	27	4
D	27	4

31. Departure Runway Occupancy Times:

Aircraft Class	Runway Occupancy Time (Seconds) Mean	Runway Occupancy Time (Seconds) Standard Deviation
A	23	3
B	26	3
C	37	4
D	37	4

32. Taxi Speeds: 5-30 mph depending on location.

33. Approach Speeds:

Aircraft Class	Approach Speed (Knots) Mean	Approach Speed (Knots) Standard Deviation
A	100	10
B	135	10
C	155	10
D	160	10

34. Gate Service Times: Not applicable.

35. Airspace Travel Times: See Table 1.

36. Runway Crossing Times:

Aircraft Class	Runway Crossing Time (Seconds)
A	12
B	14
C	17
D	20

37. Lateness Distribution: See Table 2.

38. Demand: See Table 4.

Experiment Number: 33 (Input changes from experiment number 18)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	Include High Speed Exit-Runway 17L
10 Number of runways	
11 Runway identification	
12 Departure runway and links	
13 Runway crossing links	
14 Exit taxiway location	Include High Speed Exit-Runway 17L
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	
19 Route data	Include High Speed Exit-Runway 17L
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	Include High Speed Exit-Runway 17L
29 Arrival runway occupancy times	Include High Speed Exit-Runway 17L
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	

INPUT DATA FOR 1978 ANNUAL DELAY EXPERIMENT

1. Annual Demand: 465,946 (1977)

2. Group Specification:

3 day groups	:	High, Average, Low
12 week groups	:	12 months, January through December
3 weather groups	:	VFR, IFR1, IFR2

7 runway uses :

	Arrivals Runway	Departures Runway
1.	25, 26	35
2.	35R	35L
3.	17	7, 8
4.	25, 26	26
5.	8	35
6.	17	17
7.	8	7, 8

3. Weekly Traffic:

Week Group	1	2	3	4	5	6	7	8	9	10	11	12
% of annual in one week	1.84	1.88	1.84	1.81	1.80	1.95	2.03	2.11	2.01	1.91	1.86	1.96

4. Number of Weeks in Each Group:

Week Group	1	2	3	4	5	6	7	8	9	10	11	12
Number of weeks	4.43	4.00	4.43	4.29	4.43	4.29	4.43	4.43	4.29	4.43	4.29	4.43

5. Daily Traffic:

Day Group	1	2	3
% of weekly in one day	14.9	14.5	13.4

6. Number of Days in Each Group:

Day Group	1	2	3
Number of Days	2	3	2

7. Weather Group Demand Factors:

VFR: 1.00
IFR1: 0.75
IFR2: 0.50

8. Weather Occurrences:

Week Group	1	2	3	4	5	6	7	8	9	10	11	12
% VFR	97.5	95.1	95.6	95.7	98.9	99.6	99.5	99.6	99.1	97.6	97.1	97.5
% IFR1	1.3	1.7	2.1	2.1	0.4	0.1	0.2	0.1	0.1	0.7	1.4	1.0
% IFR2	1.2	3.2	2.3	2.2	0.7	0.3	0.3	0.3	0.8	1.7	1.5	1.5

9. Hourly Runway Capacity:

	Hourly Capacity		
Runway Use	VFR	IFR1	IFR2
1	170	75	71
2	85	74	70
3	137	74	71
4	95	74	70
5	150	76	71
6	83	74	70
7	93	74	70

10. Runway Use Occurrences:

	Percent Occurrence		
Runway Use	VFR	IFR1	IFR2
1	60.00	2.50	2.50
2	--	--	1.00
3	22.00	0.05	0.05
4	3.00	--	--
5	4.00	0.05	--
6	2.00	--	--
7	1.50	--	--
Other runway uses	1.35%		

11. Hourly Traffic:

Hour	% daily traffic	Hour	% daily traffic	Hour	% daily traffic	Hour	% daily traffic
00-01	0.8	06-07	1.8	12-13	7.8	18-19	6.5
01-02	0.6	07-08	4.5	13-14	5.9	19-20	5.7
02-03	0.1	08-09	5.5	14-15	7.2	20-21	4.1
03-04	0.4	09-10	7.0	15-16	5.3	21-22	4.1
04-05	0.4	10-11	6.8	16-17	5.9	22-23	3.5
05-06	1.4	11-12	6.1	17-18	6.2	23-24	2.4

12. Demand Profile Factor: 35%

13. Runway Use Demand Factor:

All runway uses accommodate air carrier and general aviation demand (Demand factor = 1.0)

14. Aircraft Mix: 19% Class A
21% Class B
51% Class C
9% Class D

15. Percent Arrivals:

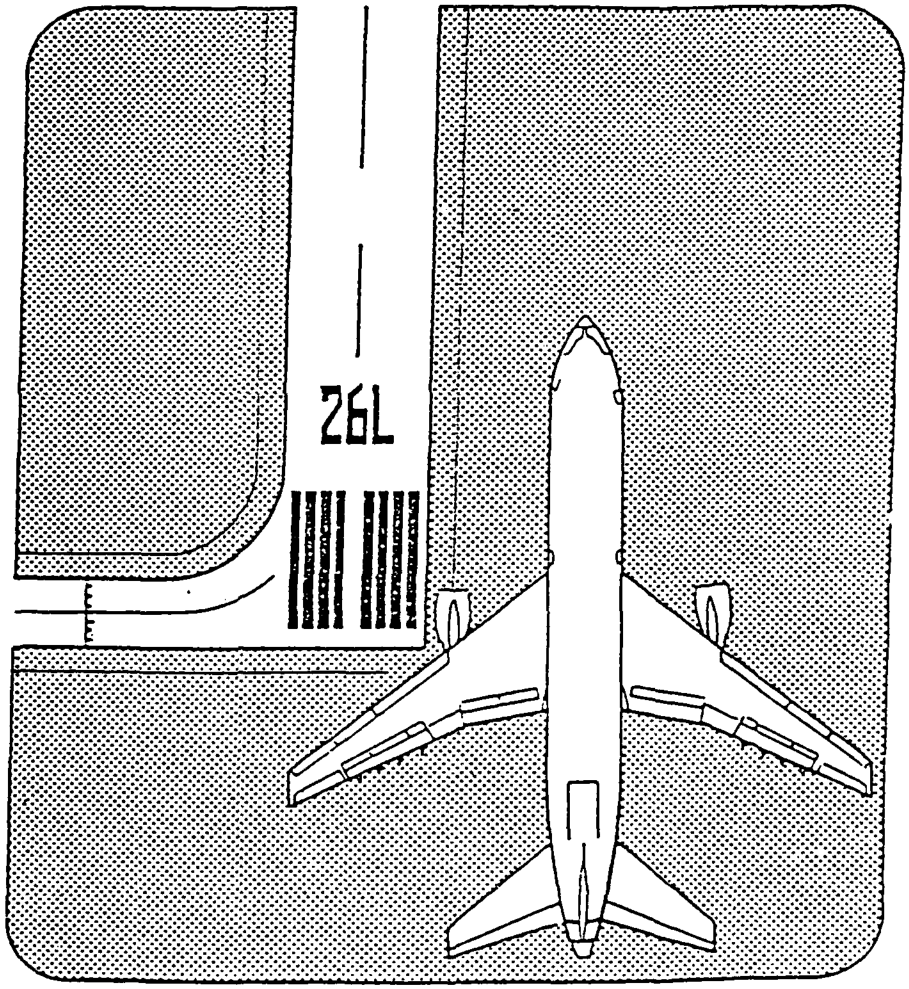
Hour	% Arrivals	Hour	% Arrivals	Hour	% Arrivals	Hour	% Arrivals
00-01	50	06-07	50	12-13	45	18-19	50
01-02	50	07-08	50	13-14	53	19-20	51
02-03	50	08-09	58	14-15	42	20-21	49
03-04	50	09-10	52	15-16	50	21-22	50
04-05	50	10-11	50	16-17	51	22-23	50
05-06	50	11-12	56	17-18	64	23-24	50

16. User-Specified Title: SIA ANNUAL BASELINE

STAPLETON INTERNATIONAL AIRPORT

DATA PACKAGE NO. 4

AIRPORT IMPROVEMENT TASK FORCE DELAY STUDIES



prepared for
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
under contract
DOT FA77WA - 3961

PMM&Co. Peat, Marwick, Mitchell & Co.
AUGUST 1978

PEAT, MARWICK, MITCHELL & CO.
P. O. BOX 8007
SAN FRANCISCO INTERNATIONAL AIRPORT
SAN FRANCISCO, CALIFORNIA 94128
Telephone: (415) 347-9521

August 29, 1978

Mr. Ray Fowler, AEM-100
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

Re: Data Package No. 4 for Stapleton Delay Experiments

Dear Ray:

Enclosed is data package No. 4 for Stapleton International Airport. The package contains the results of the Stage 1 delay experiments (Attachment A), input data revisions (Attachment B), and a suggested set of Stage 2 experiments (Attachment C). This data package should be reviewed by the Stapleton Task Force during the August 31, 1978 Task Force meeting.

Sincerely,

Steve

Stephen L. M. Hockaday
Manager

SLMH/jc
Enclosure

cc: Mr. J. R. Dupree (ALG-312)
Mr. F. Jaeger (ARM-4)

Attachment A

RESULTS OF STAGE 1 DELAY EXPERIMENTS

STAPLETON INTERNATIONAL AIRPORT

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.

August 1978

STAGE 1 EXPERIMENTS

Page Number	Experiment Number	Model	Arrival Runways	Departure Runways	Weather	Demand	ATC Scenario	Near-Term Improvements
3	2	ASM	25-26L-26R	35L-35R	VFR1	1978	1978	1978 - Baseline 1978
7	4	ASM	17L-17R	7-8L-8R	VFR1	1985	1978	1985 - Baseline 1985
10	8	ASM	25-26L-26R	35L-35R	VFR1	1978	1978	Metering Rate = 60/hr- Runway 26R equal 26L in length
12	9	ASM	25-26L-26R	35L-35R	VFR1	1985	1985	1985 - Baseline 1985
15	10	ASM	26L	35L-35R	IFR1	1985	1985	1985 - Baseline 1985
18	11	ASM	26L	35L-35R	IFR1	1985	1985	Reduce Air Carrier Demand by 10%
20	13	ASM	25-26L-26R	35L-35R	VFR1	1985	1985	Reduce GA by 50%
22	A1	ADM	N.A.	N.A.	N.A.	1978	1978	1978
26	15	ASM	35L-35R	35L-35R	IFR2	1985	1985	1985 - Baseline 1985
28	18	ASM	17L-17R	17L-17R	VFR1	1985	1985	1985 - Baseline 1985
30	29	ASM	17L-17R	7-8L-8R	VFR1	1985	1978	Ext. 26R East to equal 26L length
33	30	ASM	17L-17R	7-8L-8R	VFR1	1985	1978	Ext. Taxiway D-1 from D-2 to C-2
36	31	ASM	35R	35L	IFR2	1985	1985	ASDE
38	33	ASM	17L-17R	17L-17R	VFR1	1985	1985	High Speed Exit-Runway 17L

Experiment No. 2

Objective:

To obtain 1978 baseline delay estimates for the following runway use in VFR 1 weather:

Arrival Runways	Departure Runways
25-26L-26R	35L-35R

Related Comparison Experiments:

Experiment 8 estimates the delay impact of an arrival aircraft metering rate of 45 per hour.

Results:

Figure 2A shows that total aircraft flows vary from 38 to 124 aircraft per hour over the 16 hour simulation run. The peak hour is from 1200 to 1300 hours and contains 52 arrival aircraft and 72 departure aircraft.

Figure 2B shows that average delays to aircraft using the runways are as high as 4.7 minutes per aircraft. Peak hour average delays are 0.8 minutes for arrival aircraft and 4.7 minutes for departure aircraft.

Figure 2C shows that average delays to aircraft using the taxiways are negligible.

Figure 2D shows that average aircraft taxi travel times vary from 2.6 to 8.0 minutes. Peak-hour average taxi travel times are 3.3 minutes for arrival aircraft and 8.0 minutes for departure aircraft.

Figures 2E and 2F show variation of runway flow rates and delays by 15-minute period.

FIGURE 2A--RUNWAY FLOW RATES

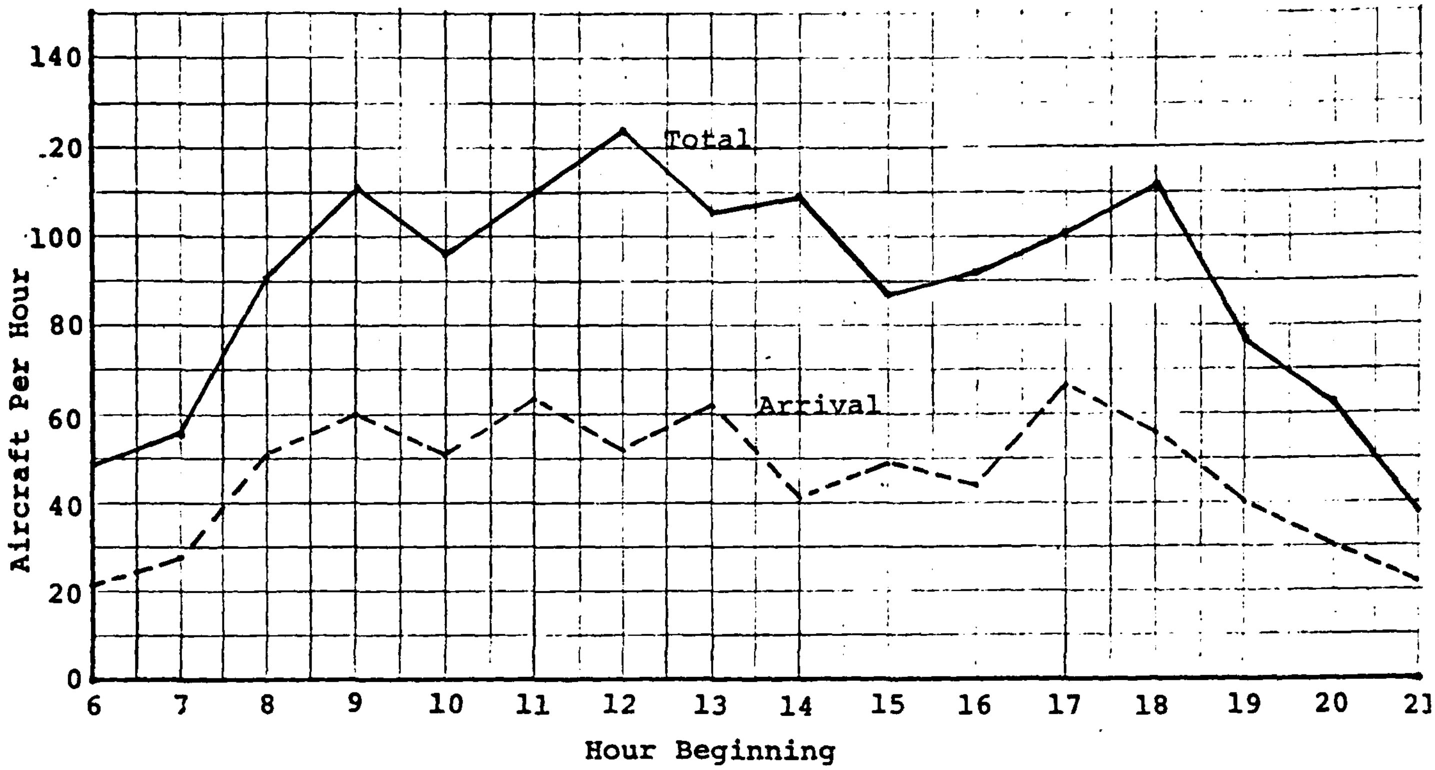


FIGURE 2B--RUNWAY DELAYS

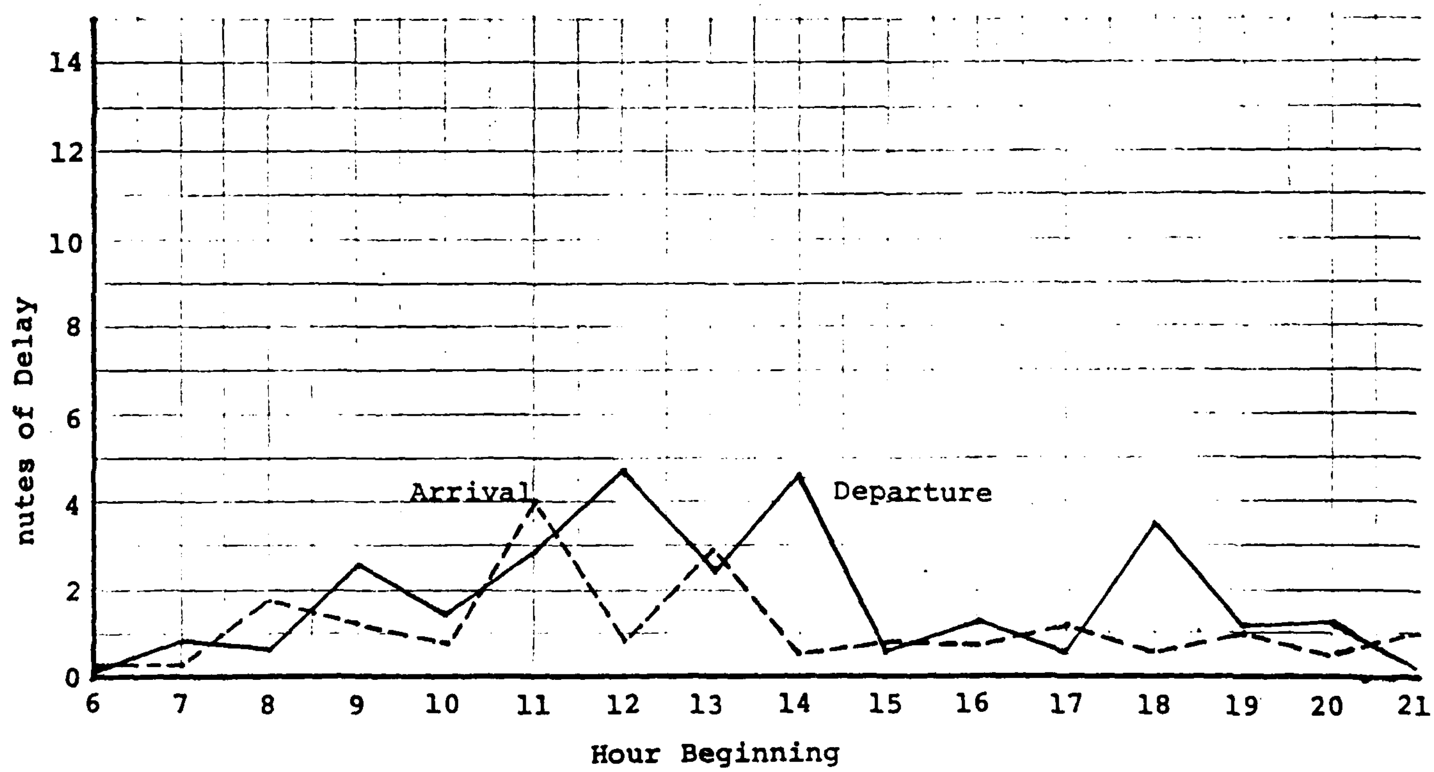


FIGURE 2C--TAXIWAY DELAYS

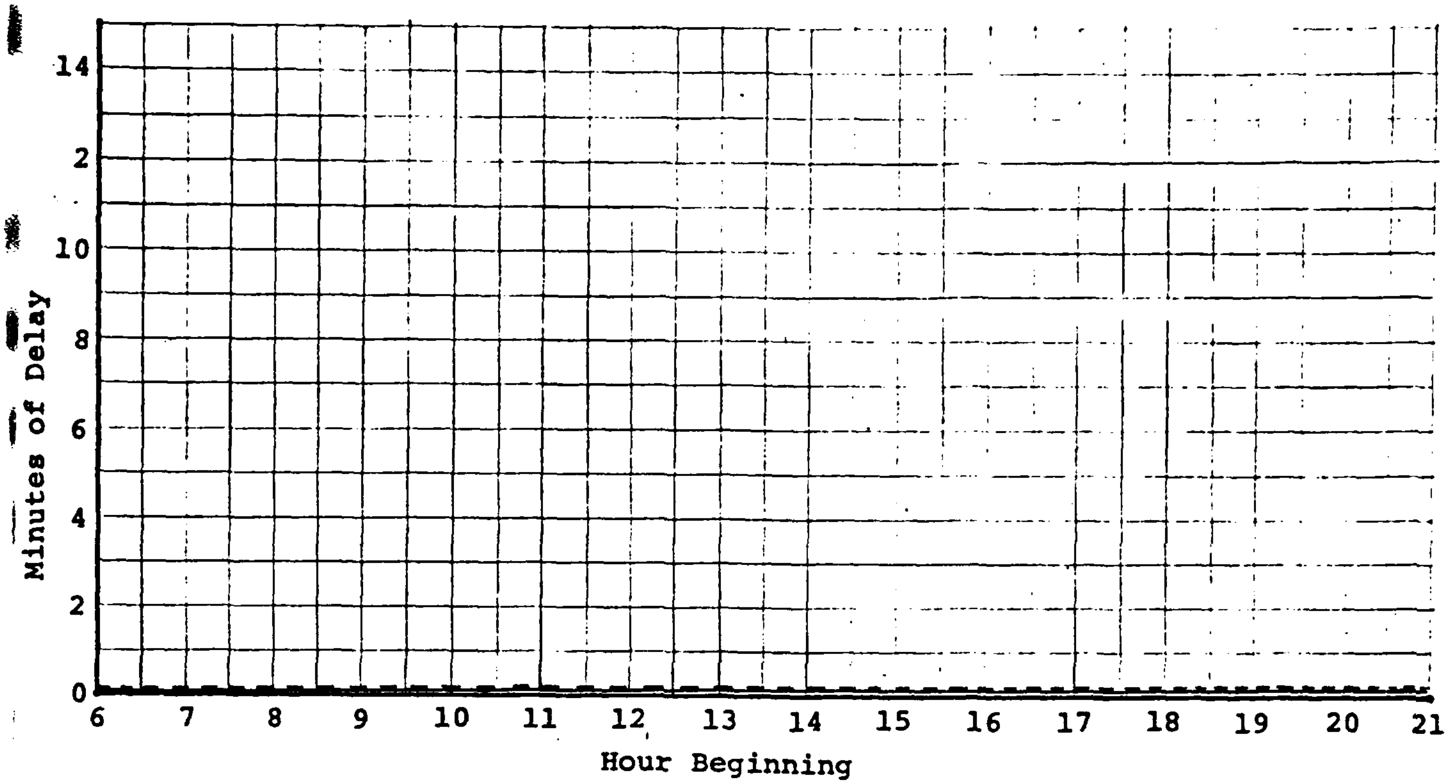


FIGURE 2D--TAXIWAY TRAVEL TIMES

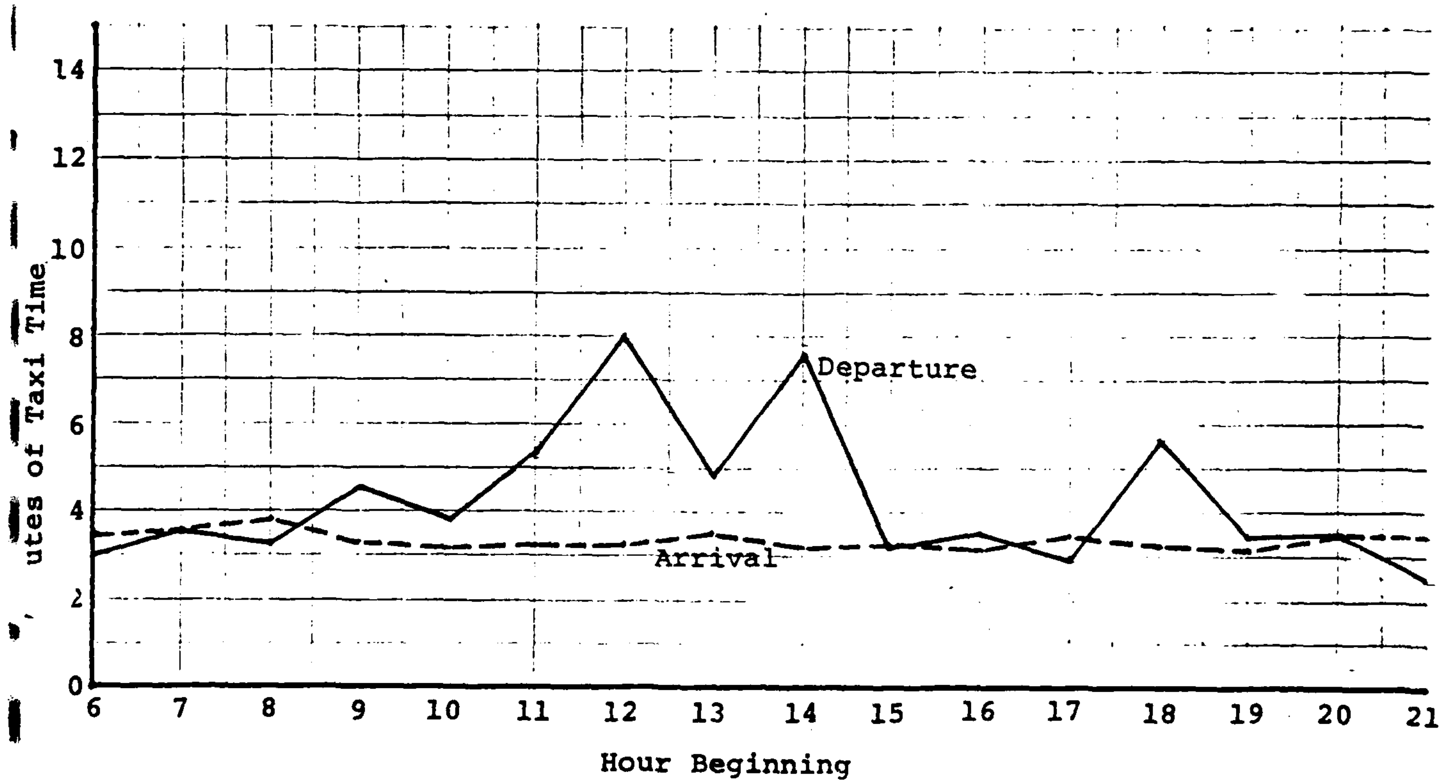


FIGURE 2E--RUNWAY FLOW RATES

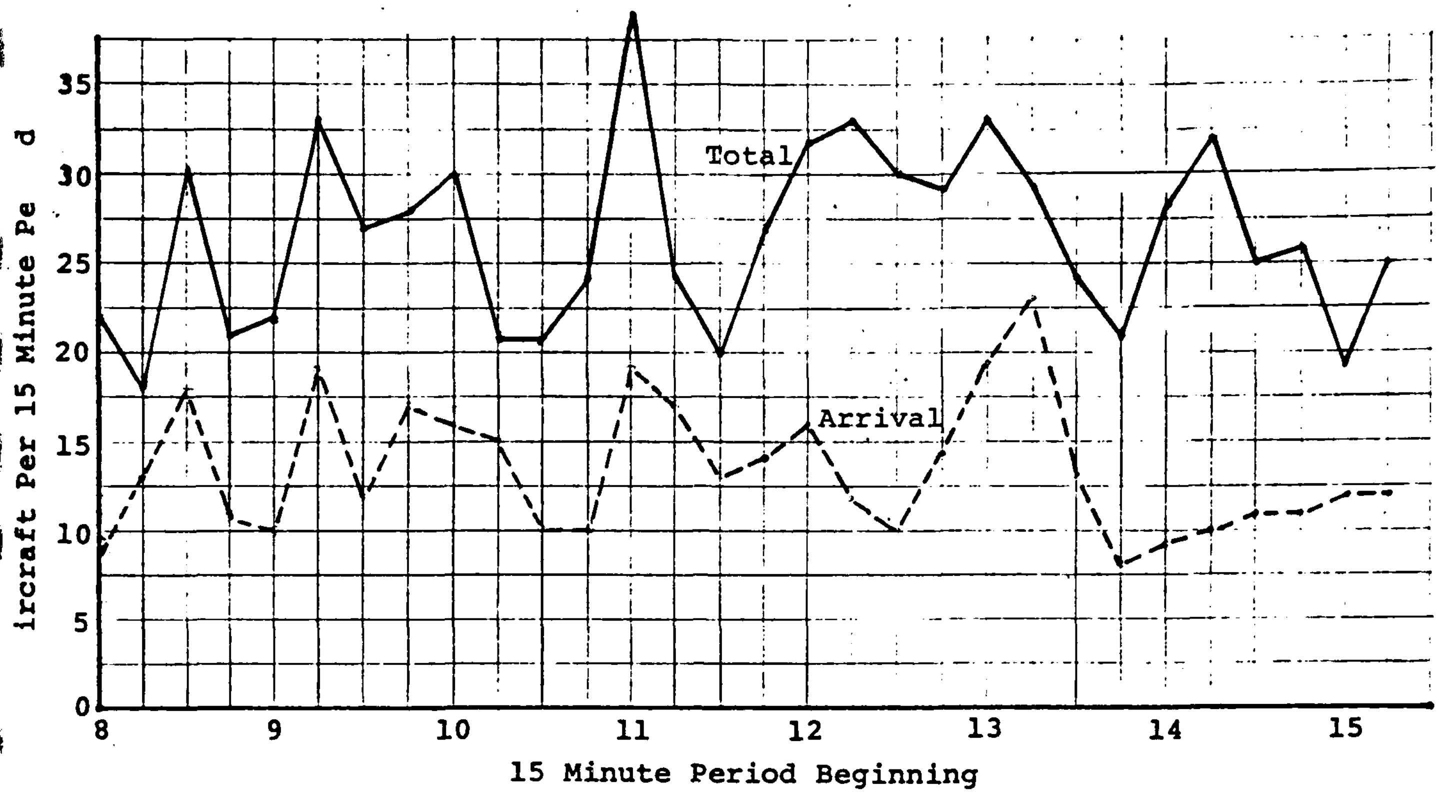
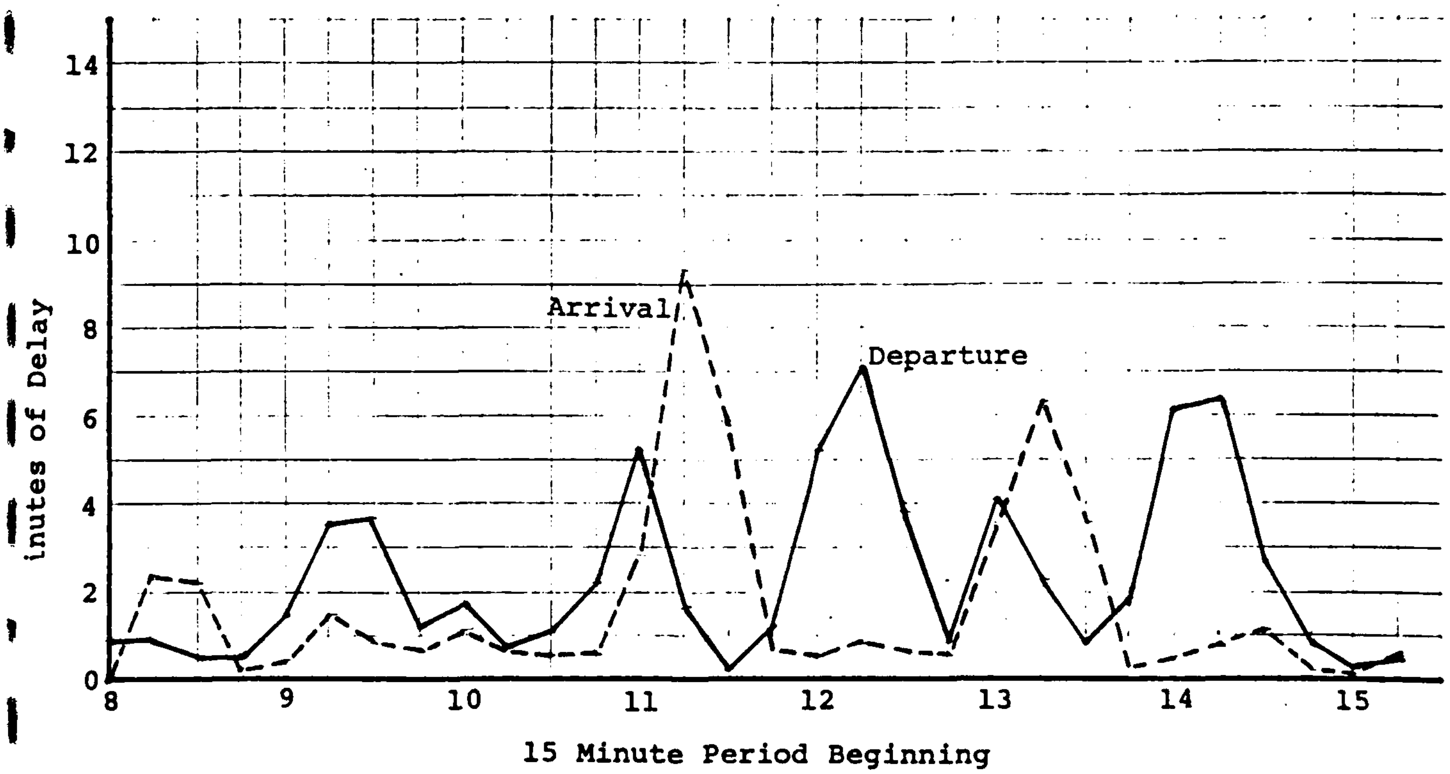


FIGURE 2F--RUNWAY DELAYS



Experiment No. 4

Objective:

To obtain 1978 baseline delay estimates for the following runway use in VFR 1 weather:

Arrival Runways	Departure Runways
17L-17R-8L	7-8R

In this experiment, the temperature is assumed to be high enough to preclude jet departures from Runway 8L.

Related Comparison Experiments:

Experiment 29 estimates the delay impact of the availability of Runway 8L for all jet departures (due to runway extension and/or low temperatures).

Results:

Figure 4A shows that total aircraft flows vary from 27 to 117 aircraft per hour over the 16 hour simulation run. The peak hour is from 1100 to 1200 hours and contains 58 arrival aircraft and 59 departure aircraft.

Figure 4B shows that average delays to aircraft using the runways are as high as 3.3 minutes per aircraft. Peak hour average delays are 2.1 minutes for arrival aircraft and 1.9 minutes for departure aircraft.

Figure 4C shows that average delays to aircraft using the taxiways are negligible.

Figure 4D shows that average aircraft taxi travel times vary from 1.3 to 5.8 minutes. Peak hour average taxi travel times are 3.6 minutes for arrival aircraft and 5.1 minutes for departure aircraft.

FIGURE 4A--RUNWAY FLOW RATES

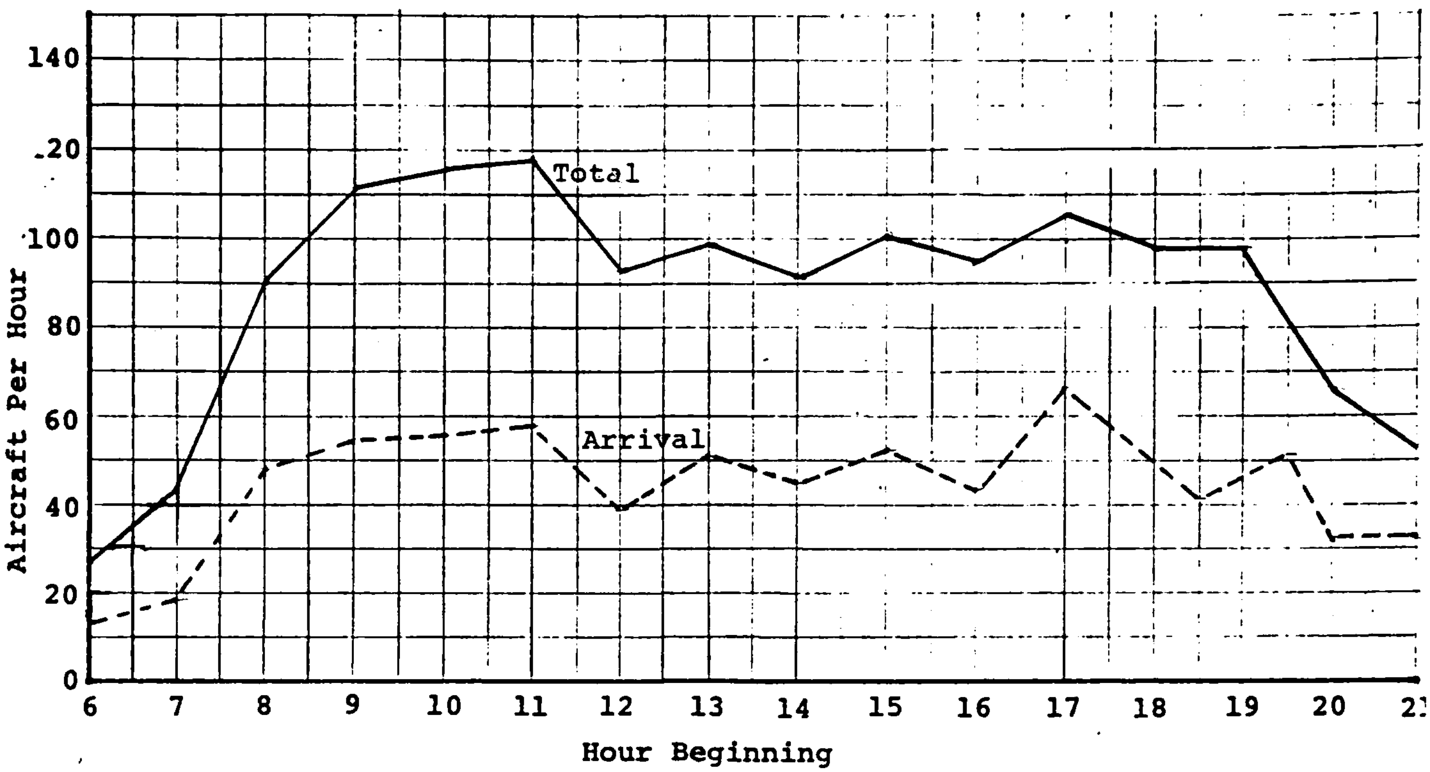


FIGURE 4B--RUNWAY DELAYS

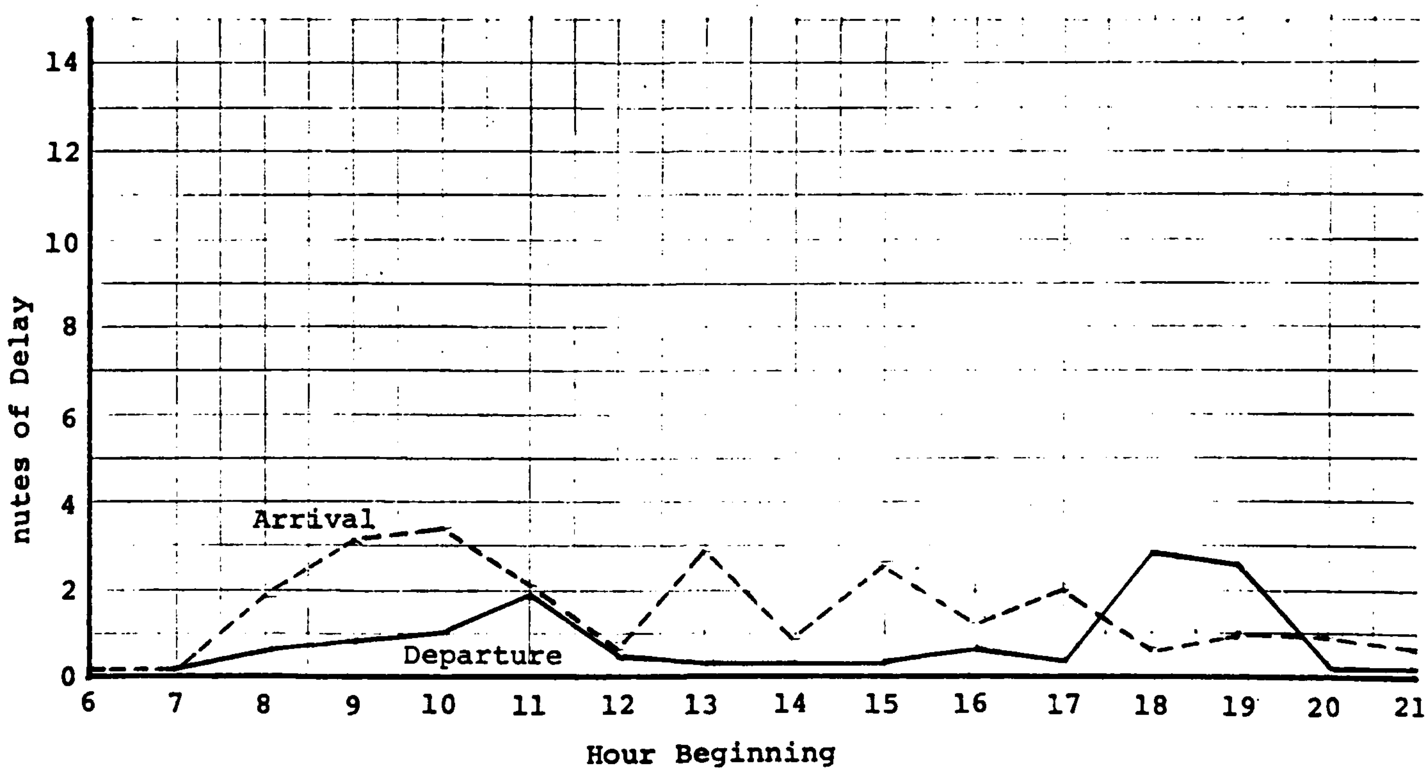


FIGURE 4 C--TAXIWAY DELAYS

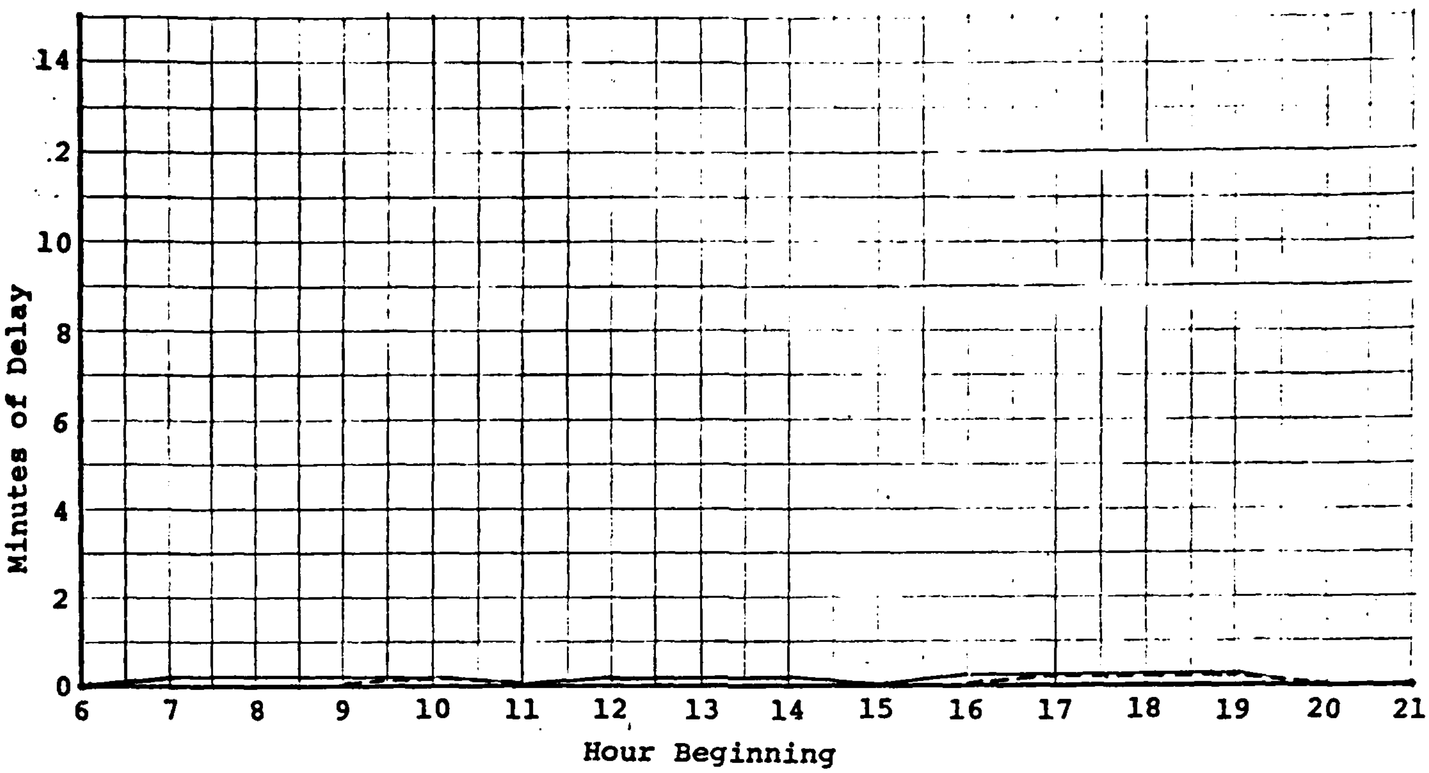
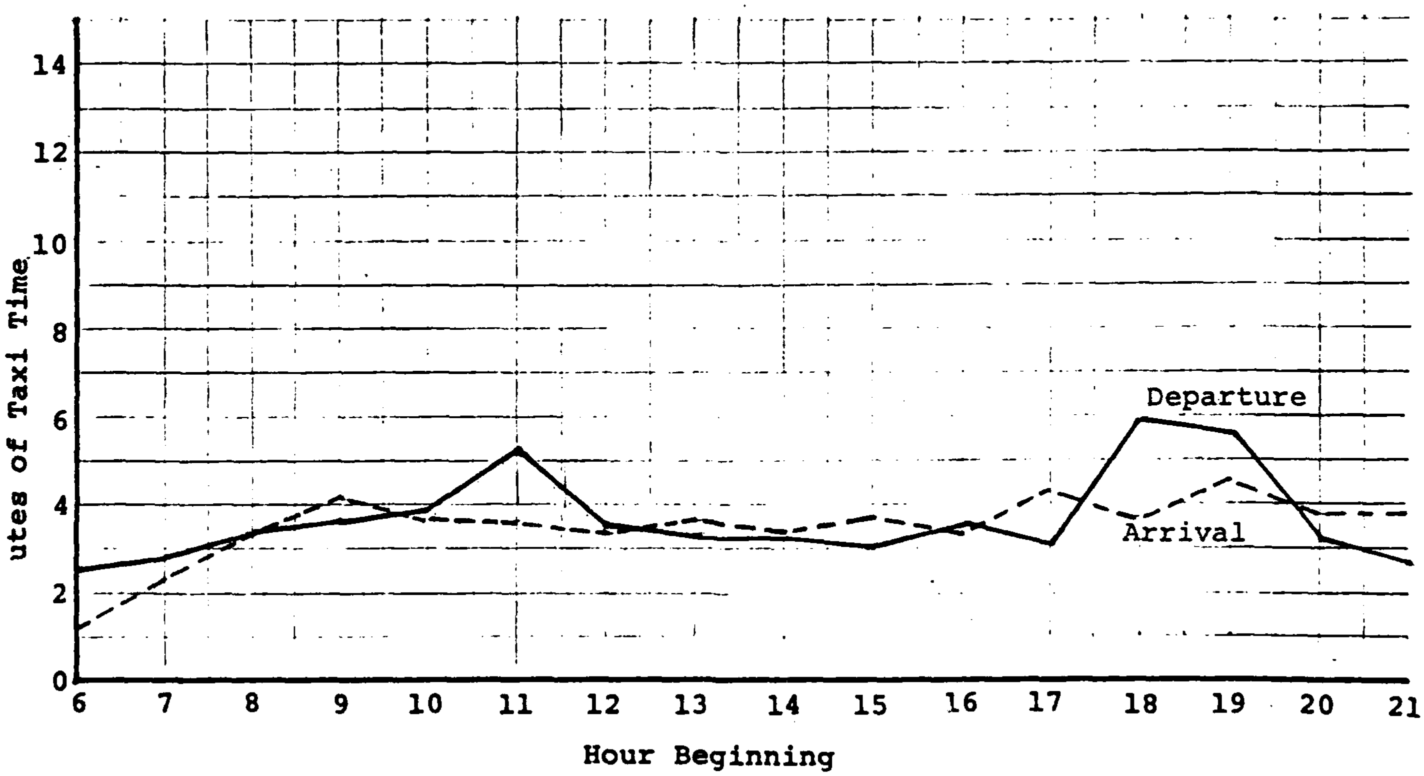


FIGURE 4 D--TAXIWAY TRAVEL TIMES



Experiment No. 8

Objective:

To estimate the delay impact of an arrival aircraft metering rate of 45 per hour.

Related Comparison Experiments:

Experiment 2 is the 1978 baseline for the comparison.

Results:

Figure 8A shows that total aircraft flows vary from 37 to 125 aircraft per hour over the 16 hour simulation run. The peak hour is from 1200 to 1300 hours and contains 55 arrival aircraft and 70 departure aircraft. 36 of the arrival aircraft were metered during the peak hour.

Figure 8B shows that average delays to aircraft using the runways are as high as 4.7 minutes per aircraft. Peak hour average delays are 1.7 minutes for arrival aircraft and 4.2 minutes for departure aircraft. The 1.7 minutes average peak hour arrival delay consists of 1.2 minutes of delay in the terminal airspace and 0.5 minutes average metering delay.*

Comparison of these flows and delays with the runway flows and delays for Experiment 2 shows that the arrival metering rate of 45 aircraft per hour causes a slight increase in overall arrival delays (0.3 minutes in the peak hour) and a slight reduction in arrival delays in the terminal airspace.

---

*The 0.5 minutes average peak hour metering delay is computed as if all aircraft were metered. In fact 36 metered aircraft received an average of 0.8 minutes of metering delay and 19 non-metered aircraft received no metering delay.

FIGURE 8A--RUNWAY FLOW RATES

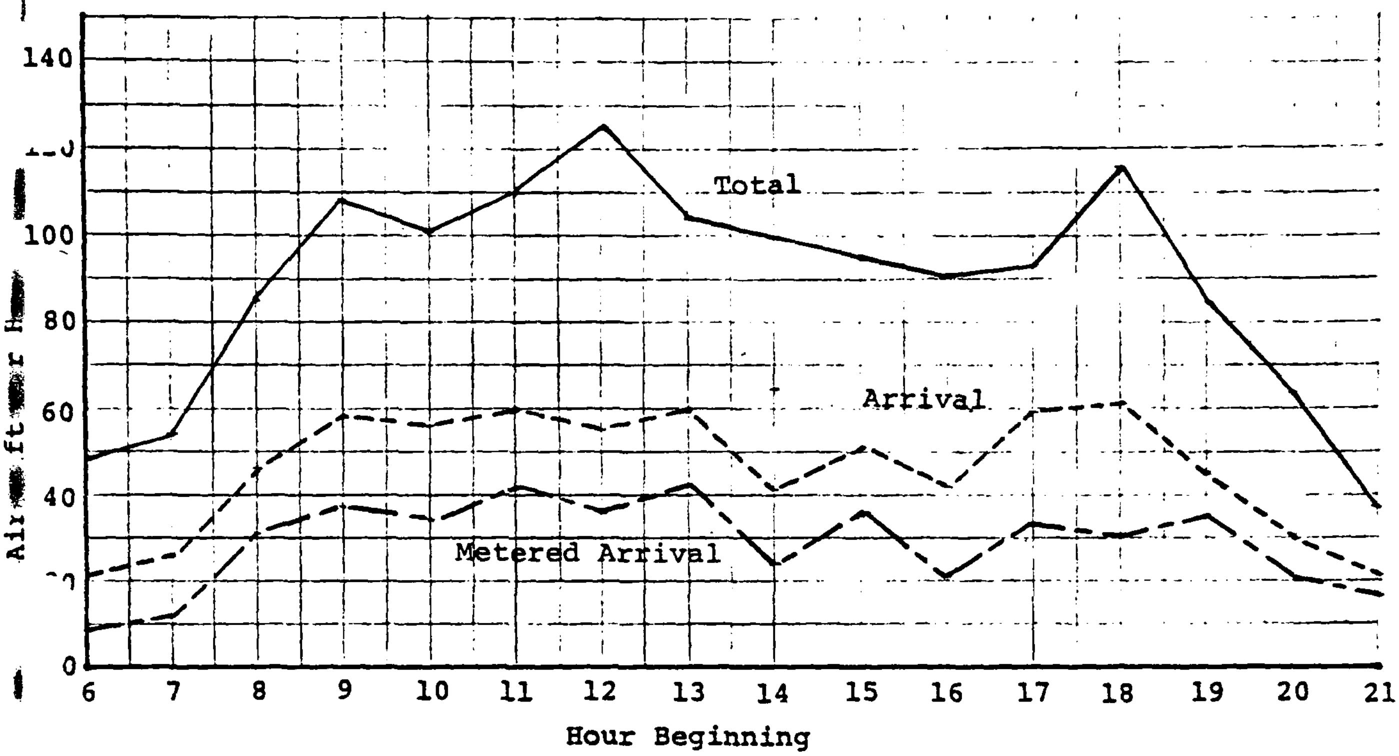
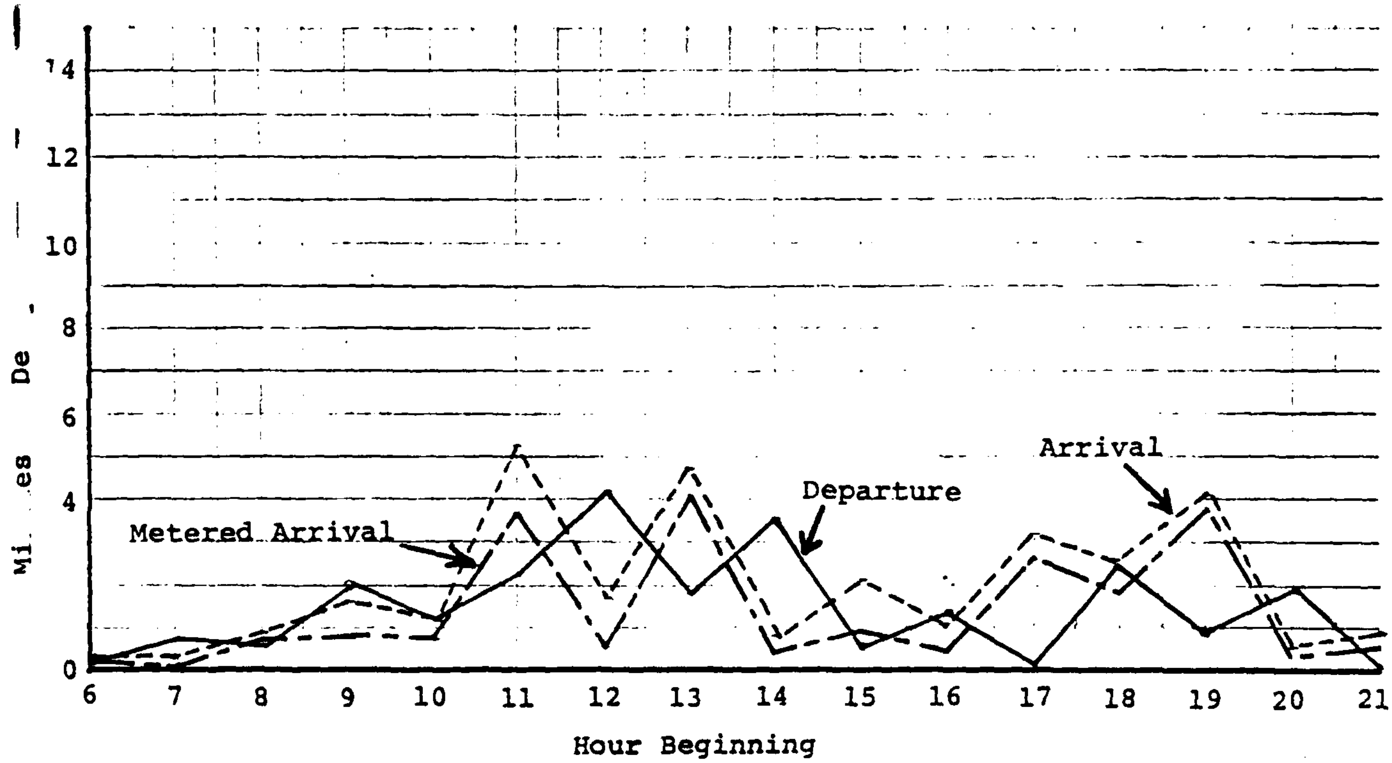


FIGURE 8B--RUNWAY DELAYS



Experiment No. 9

Objective:

To obtain 1985 baseline delay estimates for the following runway use in VFR 1 weather:

Arrival Runways	Departure Runways
25-26L-26R	35L-35R

Related Comparison Experiments:

Experiment 13 estimates the delay impact of a 50% reduction in general aviation activity.

Results:

Figure 9A shows that total aircraft flows vary from 28 to 117 aircraft per hour over the 16 hour simulation run. The peak hour is from 1000 to 1100 hours and contains 58 arrival aircraft and 59 departure aircraft.

Figure 9B shows that average delays to aircraft using the runways are as high as 4.1 minutes per aircraft. Peak hour average delays are 1.5 minutes for arrival aircraft and 3.9 minutes for departure aircraft.

Figures 9C and 9D show variation of runway flow rates and delays by 15-minute period.

FIGURE 9A--RUNWAY FLOW RATES

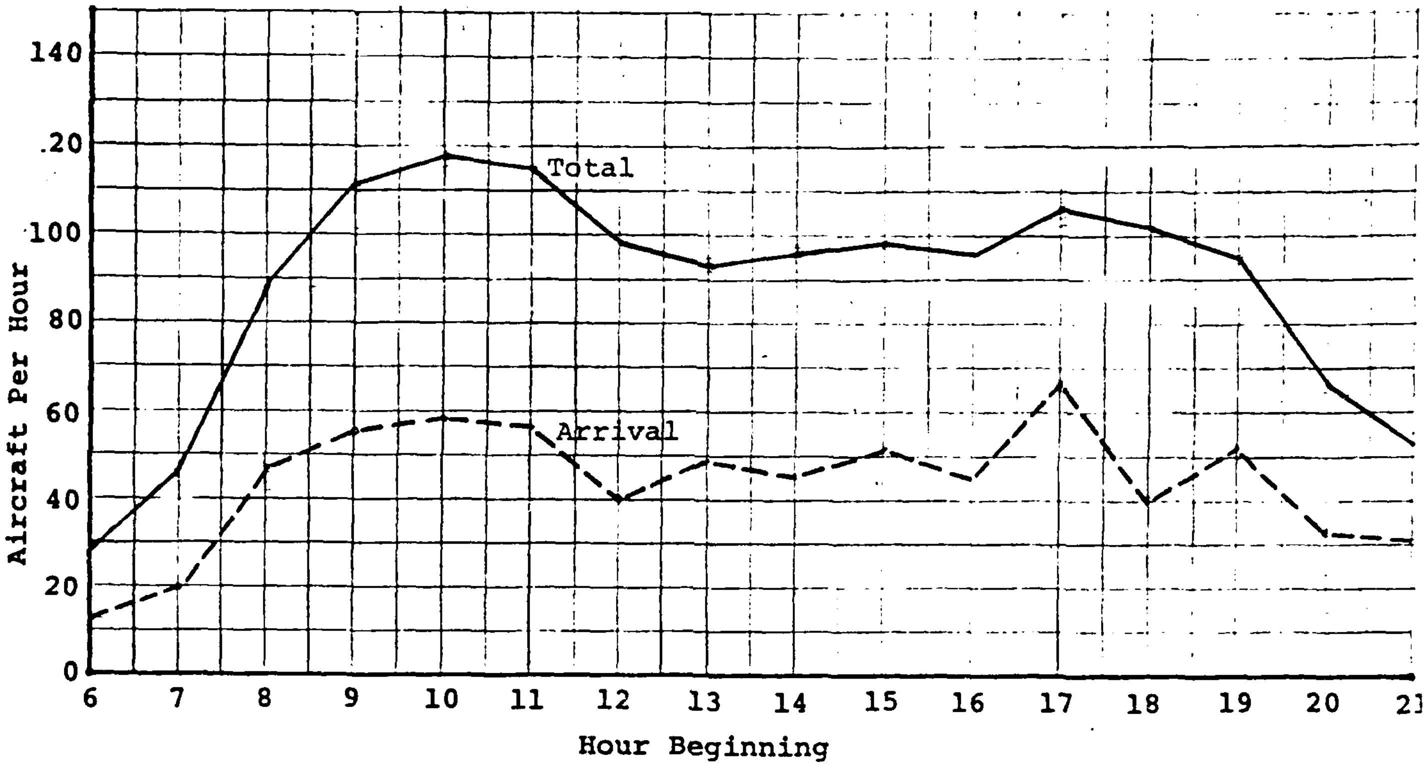


FIGURE 9B--RUNWAY DELAYS

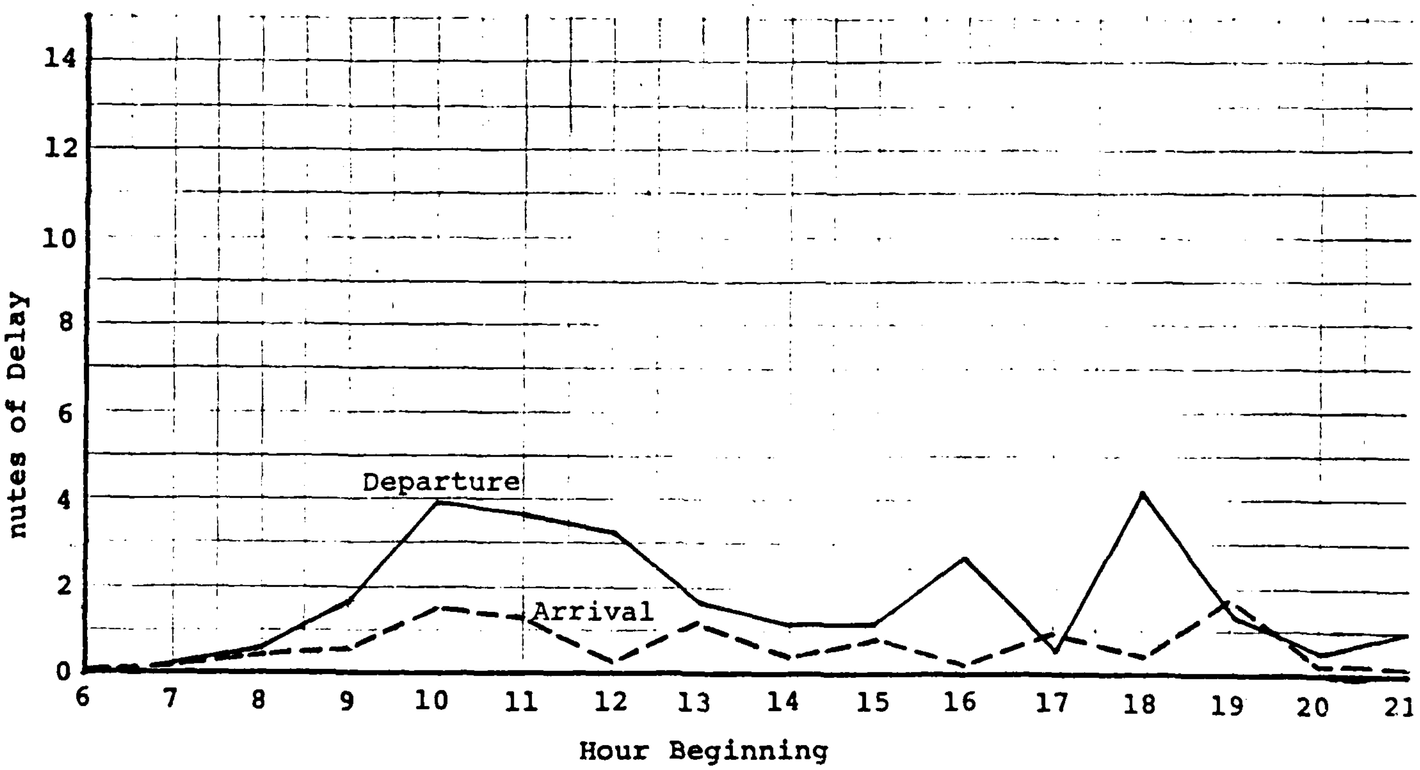


FIGURE 9C--RUNWAY FLOW RATES

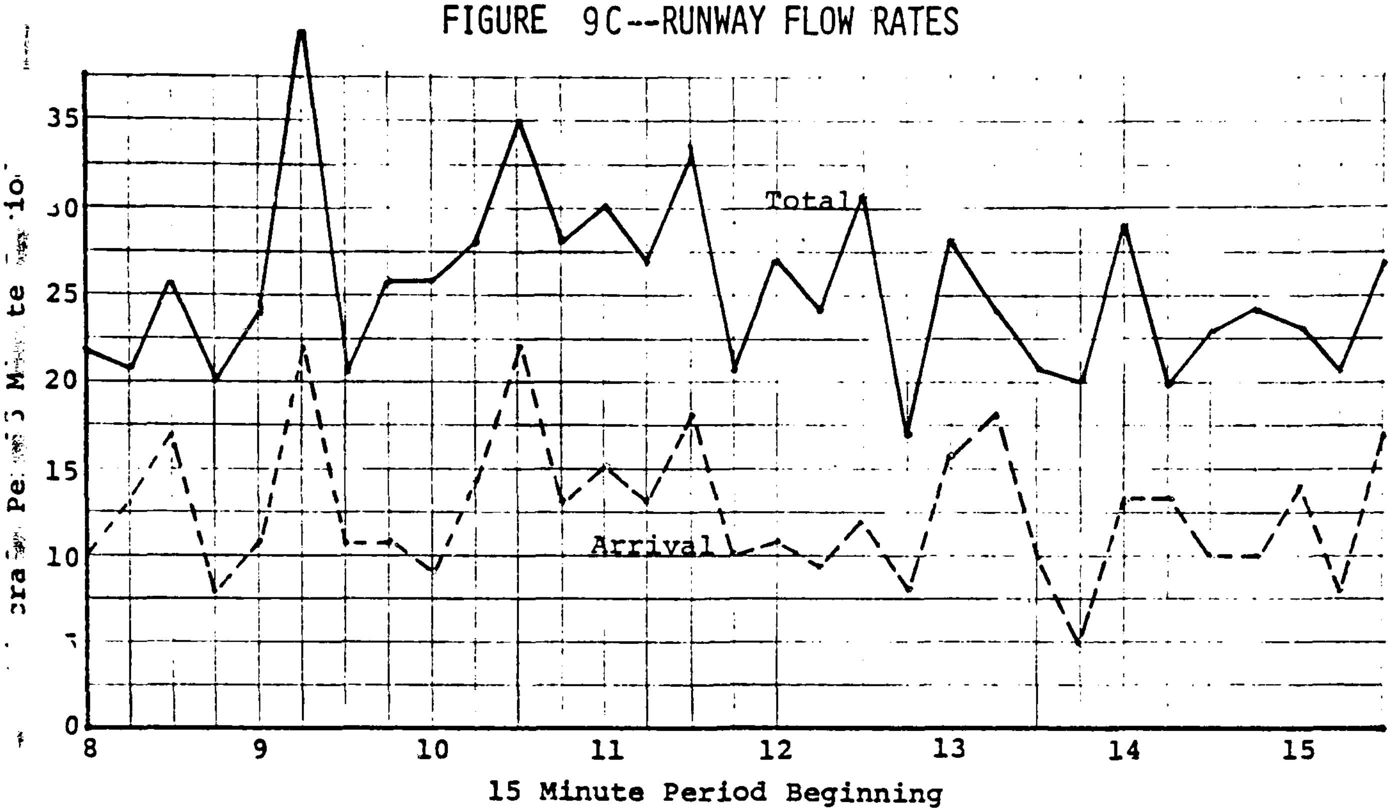
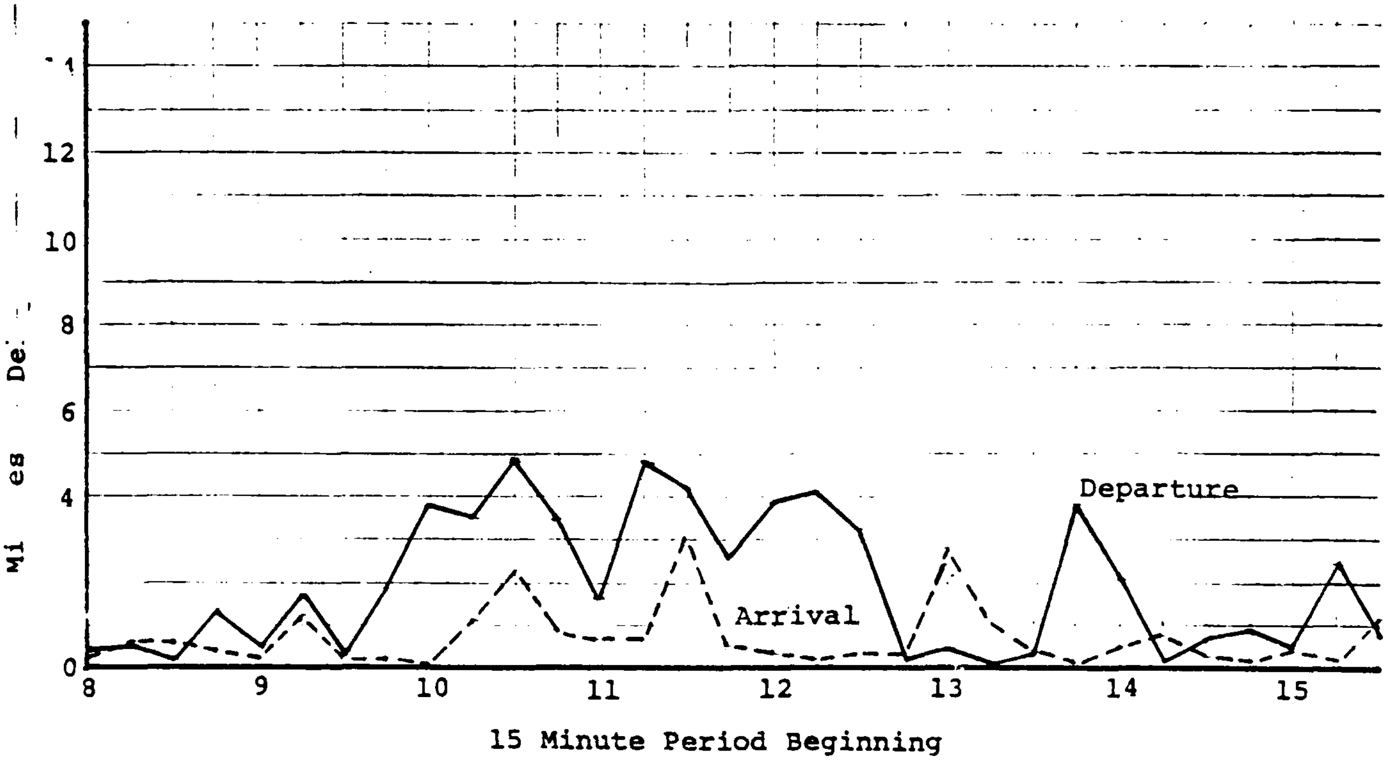


FIGURE 9D--RUNWAY DELAYS



Experiment No. 10

Objective:

To obtain 1985 baseline delay estimates for the following runway use in IFR 1 weather:

Arrival Runways	Departure Runways
26L	35L

Related Comparison Experiments:

Experiment 11 estimates the delay impact of a 10% reduction in air carrier demand.

Results:

Figure 10A shows that total aircraft flows vary from 19 to 87 aircraft per hour over the 16 hour simulation run. The peak hour in terms of flow is from 1200 to 1300 hours and contains 33 arrival aircraft and 54 departure aircraft.

Figure 10B shows that average delays to aircraft using the runways are as high as 279 minutes per aircraft. Average departure delays range from 0 to 9.3 minutes, while average arrival delays increase continually over the day to 279 minutes by the end of the 16 hours.

These very high arrival delays are due to an excess of demand over capacity, as evidenced in Figure 10C. In practice, IFR weather rarely occurs for 16 hours straight. In any event, delays of 279 minutes are unrealistic as cancellations and diversions would occur before delays build up to this level.

AD-A092 456 PEAT MARWICK MITCHELL AND CO SAN FRANCISCO CALIF F/G 1/5

TASK FORCE DELAY STUDY. DENVER STAPLETON INTERNATIONAL AIRPORT,--ETC(U)

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3 OF 4

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FIGURE 10A--RUNWAY FLOW RATES

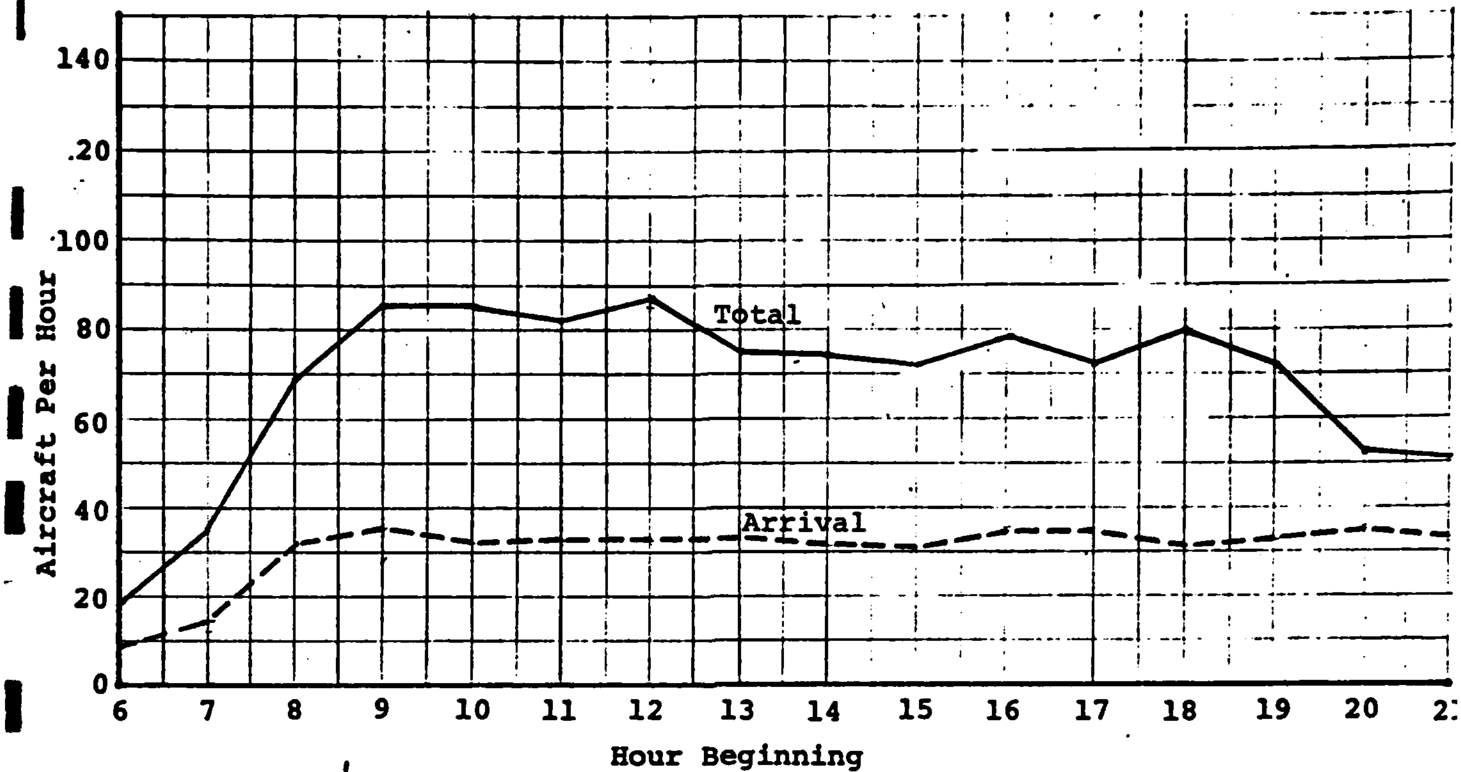


FIGURE 10B--RUNWAY DELAYS

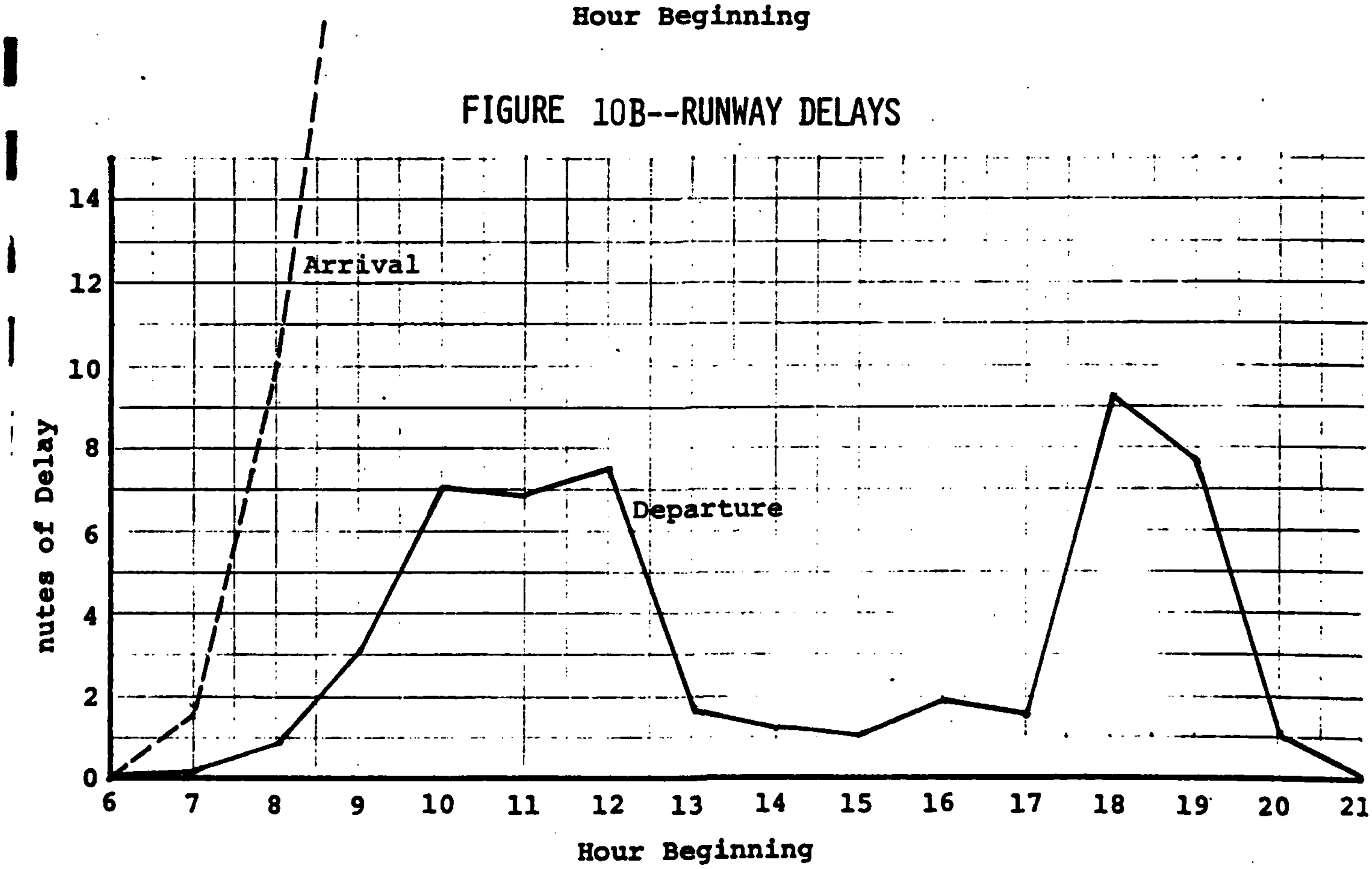
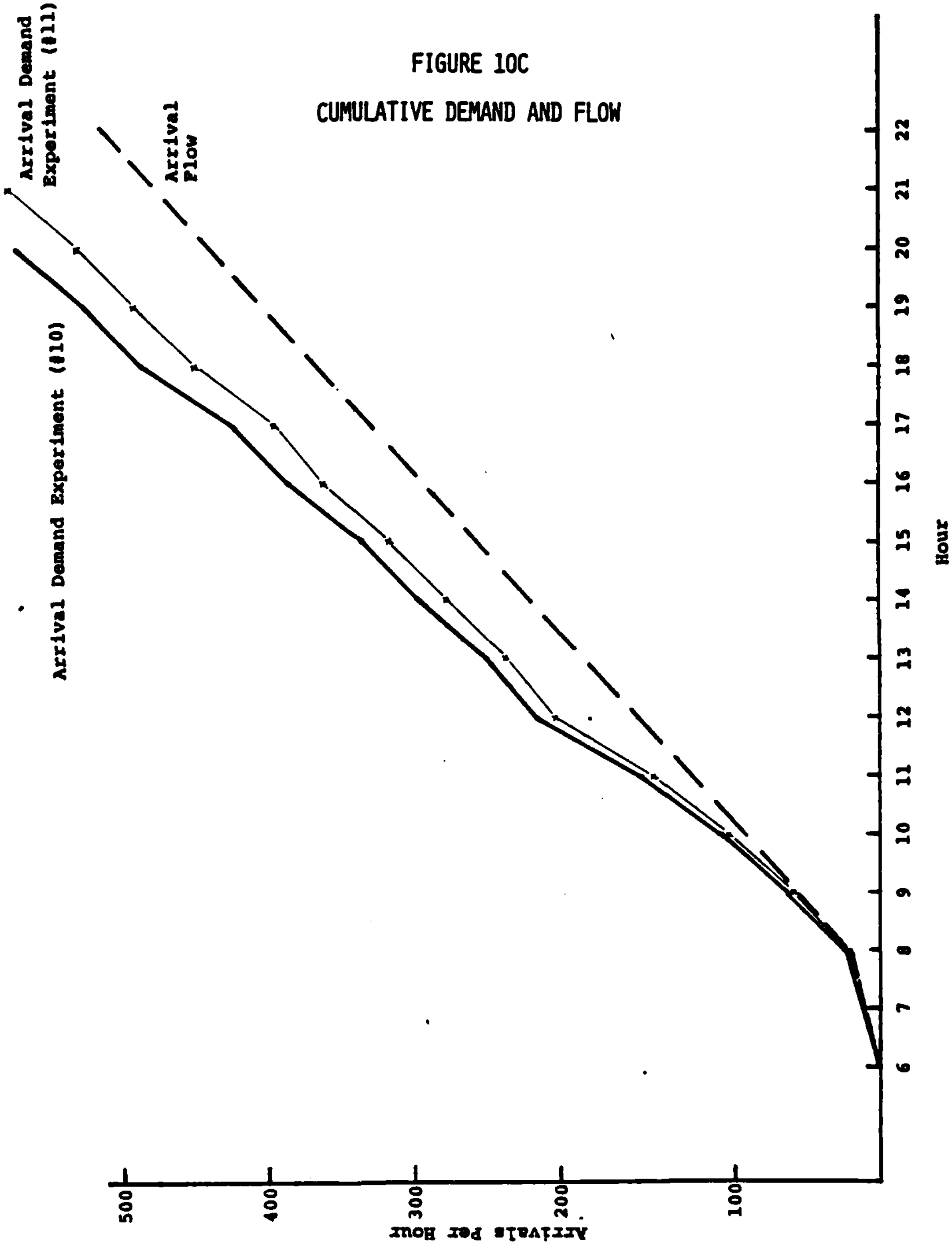


FIGURE 10C

CUMULATIVE DEMAND AND FLOW



Experiment No. 11

Objective:

To estimate the delay impact of a 10% reduction in air carrier demand.

Related Comparison Experiments:

Experiment 10 is the 1985 baseline for comparison.

Results:

Figure 11A shows that total aircraft flows vary from 0 to 86 aircraft per hour over the 16 hour simulation run. The peak hour in terms of flow is from 1000 to 1100 hours and contains 34 arrival aircraft and 52 departure aircraft.

Figure 11B shows that average delays to aircraft using the runways are as high as 202 minutes per aircraft. Departure delays range from 0 to 4.7 minutes, while arrival delays increase continually over the day to 202 minutes by the end of the 16 hours. These very high arrival delays are due to an excess of demand over capacity, as evidenced in Figure 10C. In practice, IFR weather rarely occurs for 16 hours straight. In any event, delays of 202 minutes are unrealistic as cancellations and diversions would occur before delays build up to this level.

Comparison of the delays between 1000 and 1100 hours with corresponding delays for Experiment 10 shows that delays are reduced by 14% for arrival aircraft and 60% for departure aircraft. These percentages vary significantly from hour to hour.

FIGURE 11A--RUNWAY FLOW RATES

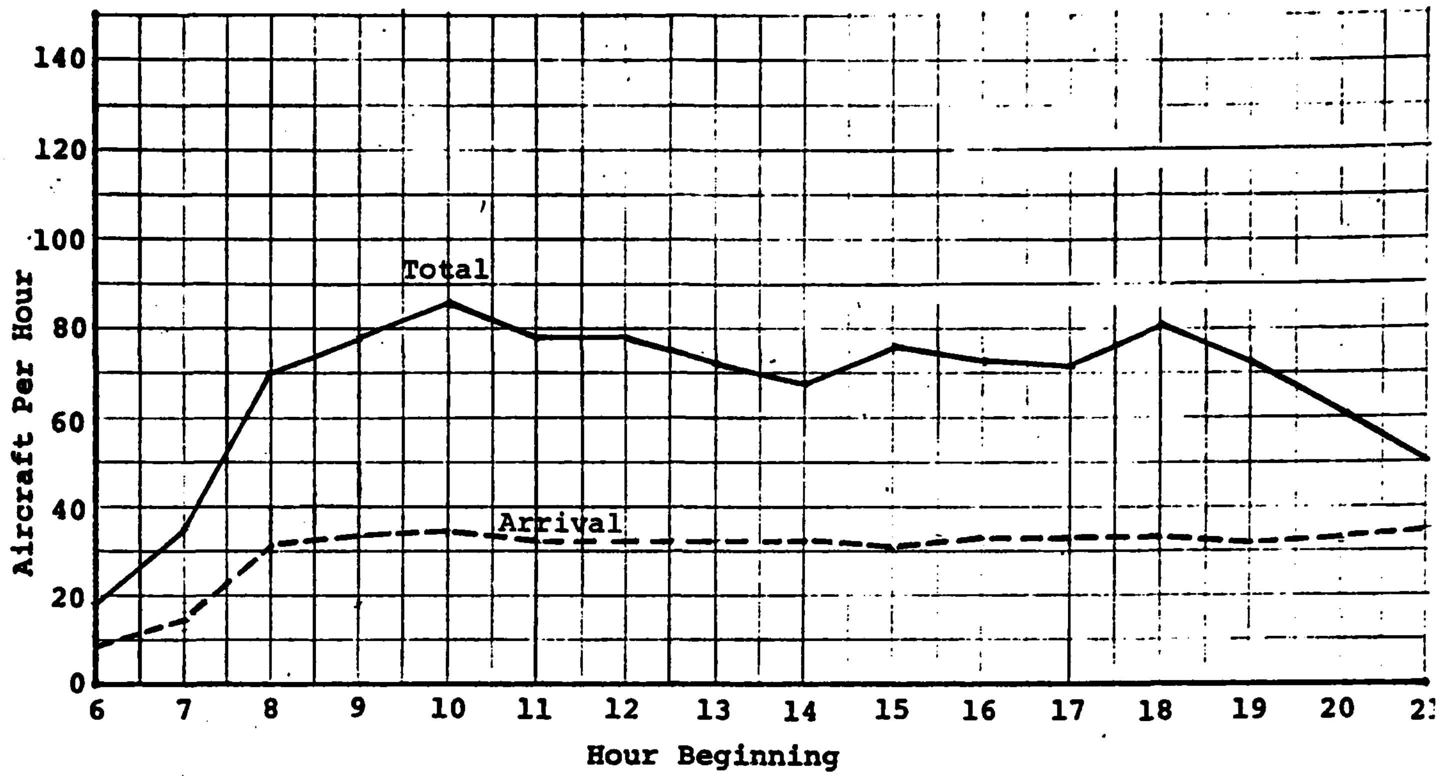
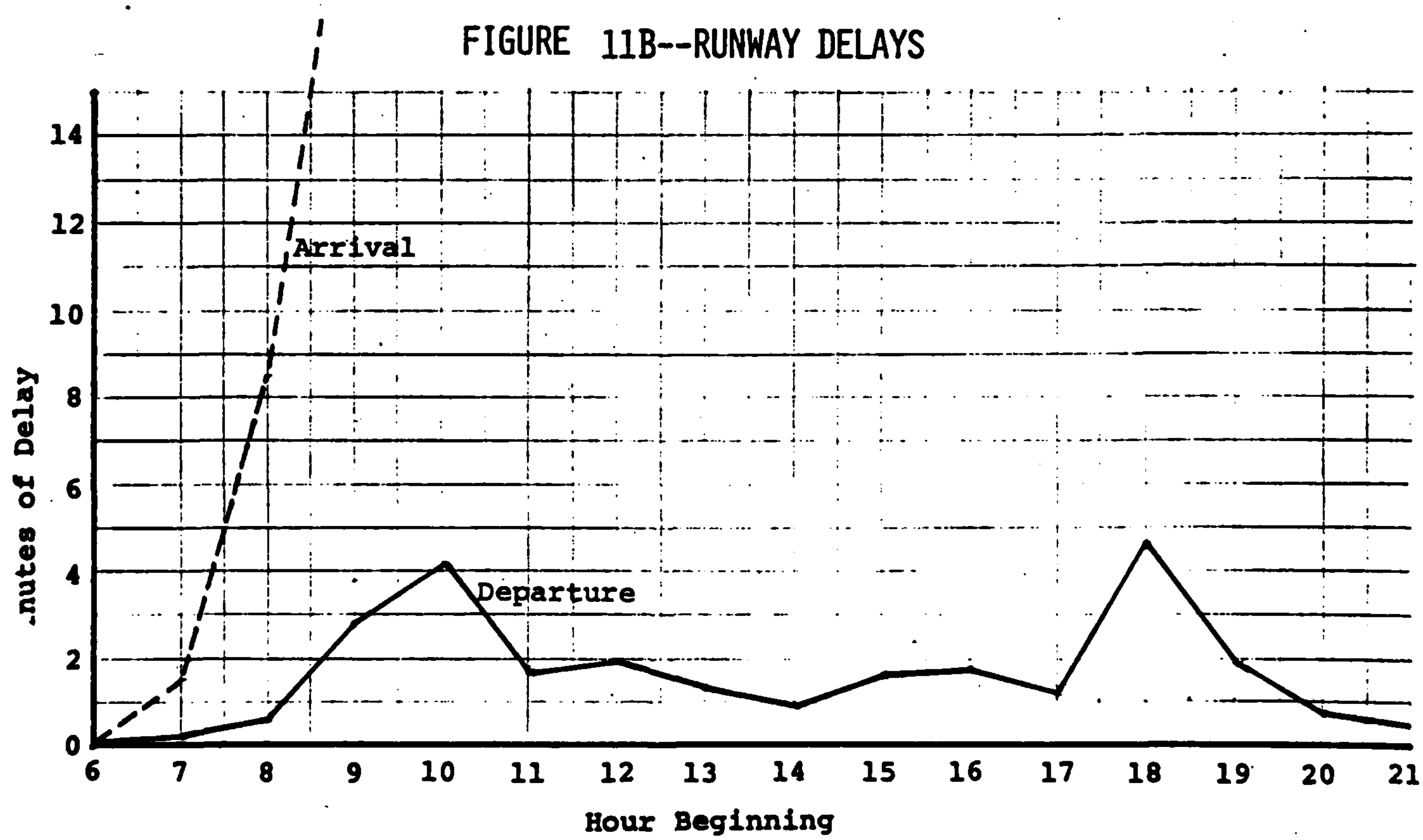


FIGURE 11B--RUNWAY DELAYS



Experiment No. 13

Objective:

To estimate the delay impact of a 50% reduction in general aviation demand.

Related Comparison Experiments:

Experiment 9 is the 1985 baseline for comparison.

Results:

Figure 13A shows that total aircraft flows vary from 18 to 106 aircraft per hour over the 16 hour simulation run. The peak hour is from 1000 to 1100 hours and contains 53 arrival aircraft and 53 departure aircraft.

Figure 13B shows that average delays to aircraft using the runways are as high as 4.4 minutes per aircraft. Peak hour average delays are 1.5 minutes for arrival aircraft and 3.0 minutes for departure aircraft.

Comparison of these delays with the delays for Experiment 9 shows that small savings in delays (0 to 1 minute) can be obtained by a 50% reduction in general aviation demand. The savings are small because delays were also small in the baseline case. Larger savings would occur in IFR weather.

FIGURE 13A--RUNWAY FLOW RATES

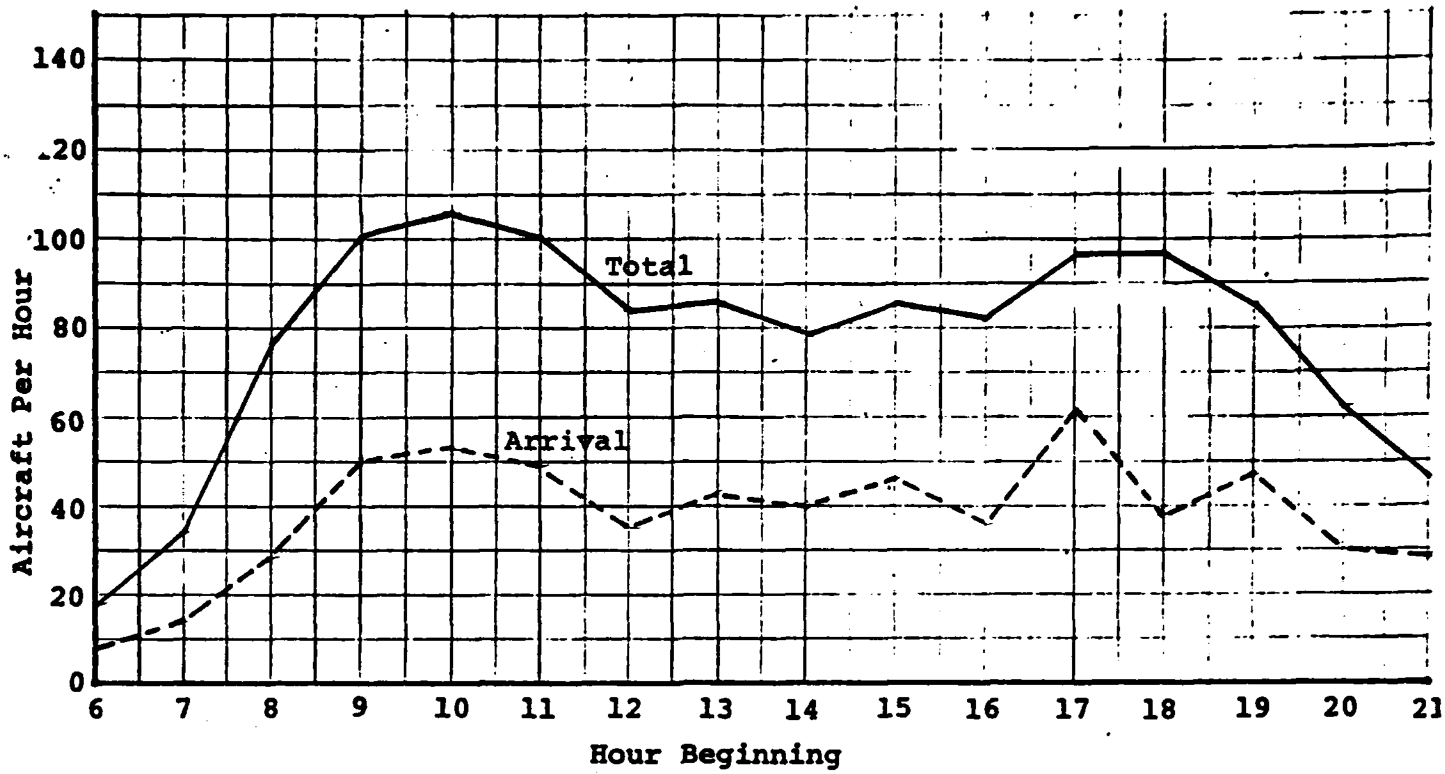
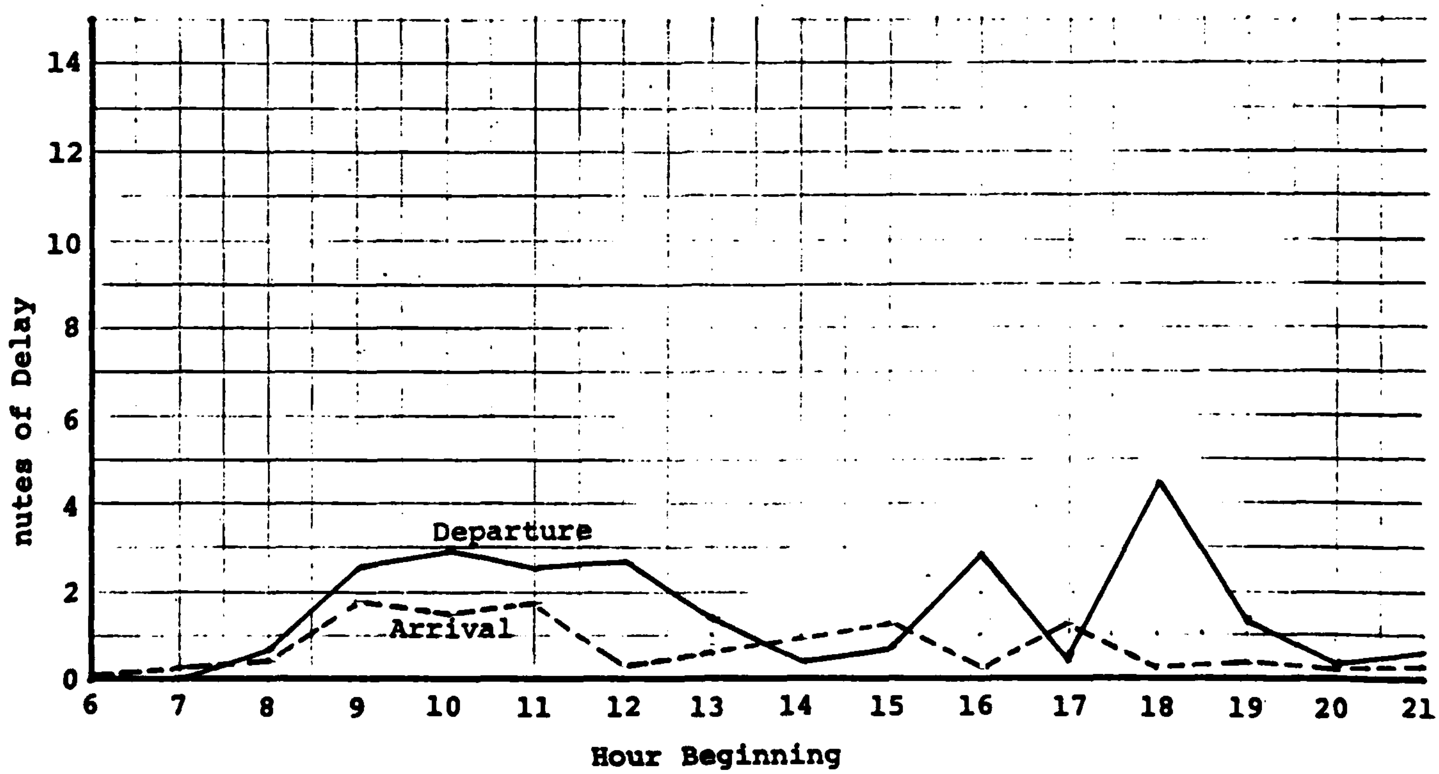


FIGURE 13B--RUNWAY DELAYS



Experiment No. A1

Objective:

To determine average annual delays to aircraft in 1978.

Related Comparison Experiments:

None in Stage 1.

Results:

With an annual demand of 512,500 operations, average annual delays were estimated to be 1.8 minutes per aircraft. Seventy-one percent of the delays were less than or equal to one minute.

On the average day of the peak month, peak hour average delays are as high as 64 minutes (during IFR 1 weather conditions with arrivals on Runway 17R and departures on Runway 8R). For the most frequent combination of runway use and weather condition (VFR 1 weather with arrivals on Runways 25, 26L and 26R and departures on Runways 35L and 35R), average peak hour delays were 1.6 minutes.

Figure A1--1978 ANNUAL DELAY BASELINE
ANNUAL SUMMARY

```
**********************************
*   AIRPORT STUDY CONDITIONS     *
*      DENVER 1978 BASELINE      *
**********************************
```

```
**************************************************************************
```

ANNUAL SUMMARY

DEMAND TO CAPACITY (D/C RATIO) AT LEAST		LESS THAN	DISTRIBUTION PERCENT OCCURRENCE
0.0	TO	.1	15.59
.1	TO	.2	8.07
.2	TO	.3	16.15
.3	TO	.4	8.53
.4	TO	.5	11.61
.5	TO	.6	16.18
.6	TO	.7	9.98
.7	TO	.8	5.95
.8	TO	.9	4.50
.9	TO	1.0	1.61
1.0	TO	1.1	.59
1.1	TO	1.2	1.05
1.2	TO	1.3	.18
1.3	TO	1.4	.00

MEAN OF D/C RATIO = .41
STANDARD DEVIATION = .26

```
**************************************************************************
```

ANNUAL DELAY =15394.945 HOURS
ANNUAL DEMAND = 512500 OPERATIONS
AVERAGE DELAY = 1.80 MINUTES/AIRCRAFT

Figure A2--1978 ANNUAL DELAY BASELINE ANNUAL DELAY DISTRIBUTION

AVERAGE DELAY (MINUTES) AT LEAST		LESS THAN	DISTRIBUTION PERCENT OCCURRENCE
0.0	TO	.2	7.649
.2	TO	.4	16.073
.4	TO	.6	13.019
.6	TO	.8	18.686
.8	TO	1.0	15.142
1.0	TO	1.2	6.160
1.2	TO	1.4	4.954
1.4	TO	1.6	3.332
1.6	TO	1.8	2.624
1.8	TO	2.0	2.428
2.0	TO	3.0	5.798
3.0	TO	4.0	1.391
4.0	TO	5.0	.180
5.0	TO	6.0	.067
6.0	TO	7.0	.079
7.0	TO	8.0	.042
8.0	TO	9.0	.037
9.0	TO	10.0	.062
21.0	TO	22.0	.081
22.0	TO	23.0	.063
23.0	TO	24.0	.035
25.0	TO	26.0	.023
26.0	TO	27.0	.045
27.0	TO	28.0	.011
28.0	TO	29.0	.107
29.0	TO	30.0	.076
30.0	TO	31.0	.020
31.0	TO	32.0	.130
32.0	TO	33.0	.016
33.0	TO	34.0	.028
34.0	TO	35.0	.090
35.0	TO	36.0	.066
37.0	TO	38.0	.078
38.0	TO	39.0	.009
39.0	TO	40.0	.036
40.0	TO	41.0	.062
41.0	TO	42.0	.039
42.0	TO	43.0	.113
43.0	TO	44.0	.006
44.0	TO	45.0	.124
45.0	TO	46.0	.078
46.0	TO	47.0	.103
47.0	TO	48.0	.094
48.0	TO	49.0	.050
49.0	TO	50.0	.063
50.0	TO	51.0	.002
51.0	TO	52.0	.073
52.0	TO	53.0	.036
53.0	TO	54.0	.024
54.0	TO	55.0	.057
56.0	TO	57.0	.015
57.0	TO	58.0	.090
59.0	TO	60.0	.087
60.0	TO	61.0	.082
61.0	TO	62.0	.084
62.0	TO	63.0	.070
63.0	TO	64.0	.003
64.0	TO	65.0	.002
65.0	TO	66.0	.002
66.0	TO	67.0	.000

MEAN OF AVERAGE DELAY = 1.80
STANDARD DEVIATION = 2.77

Figure A3--1978 ANNUAL DELAY BASELINE
AVERAGE DAY, PEAK MONTH,
PEAK HOUR DELAYS

AVERAGE PEAK HOUR DELAY FOR
PEAK MONTH, AVG. DAY

RUNWAY USE	WEATHER GROUP	PERCENT OCCURRENCE	PEAK HOUR AVERAGE DELAY (MINUTES)	NUMBER OF SATURATED HOURS	NUMBER OF OVERLOAD HOURS
1	1	59.5	1.6	0	0
1	2	4.0	3.3	0	0
1	3	.9	63.6	18	11
1	4	1.4	26.7	12	10
2	1	0.0	0.0	0	0
2	2	0.0	0.0	0	0
2	3	0.0	0.0	0	0
2	4	.6	53.9	15	11
3	1	21.3	2.9	2	1
3	2	2.0	3.4	3	1
3	3	.0	64.1	18	11
3	4	.1	43.8	14	11
4	1	3.1	3.3	0	0
4	2	0.0	0.0	0	0
4	3	0.0	0.0	0	0
4	4	0.0	0.0	0	0
5	1	4.2	3.7	0	0
5	2	0.0	0.0	0	0
5	3	.0	63.6	18	11
5	4	0.0	0.0	0	0
6	1	2.1	59.2	17	11
6	2	0.0	0.0	0	0
6	3	0.0	0.0	0	0
6	4	0.0	0.0	0	0
7	1	1.6	4.1	0	0
7	2	0.0	0.0	0	0
7	3	0.0	0.0	0	0
7	4	0.0	0.0	0	0

Experiment No. 15

Objective:

To obtain 1985 baseline delay estimates for the following runway use in IFR 2 weather:

Arrival Runway	Departure Runway
35R	35L

Related Comparison Experiments:

Experiment 31 estimates the delay impact of the implementation of ASDE.

Results:

This experiment was performed for the six hours between 0600 and 1200 hours. By 1200 hours, arrival delays were in excess of 2.5 hours and the run was stopped.

The high delays are due to an excess of demand over capacity.

Figure 15A shows that total aircraft flows vary from 8 to 60 aircraft per hour over the 6 hour simulation run. The peak hour is from 0800 to 0900 hours and contains 31 arrival aircraft and 29 departure aircraft.

Figure 15B shows that average delays to aircraft using the runways are as high as 154 minutes per aircraft. Average delays reach 154 minutes for arrival aircraft and 86 minutes for departure aircraft by 1200 hours.

FIGURE 15A--RUNWAY FLOW RATES

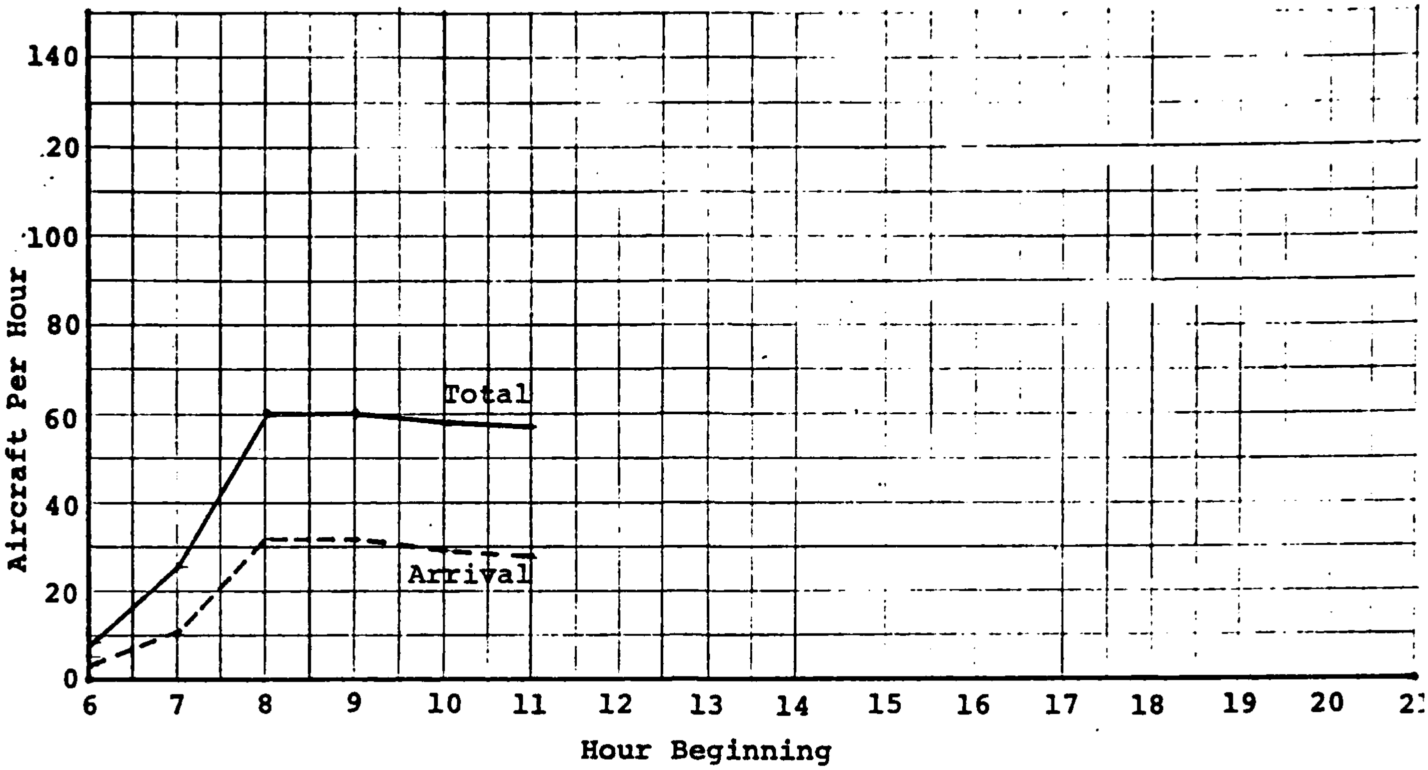
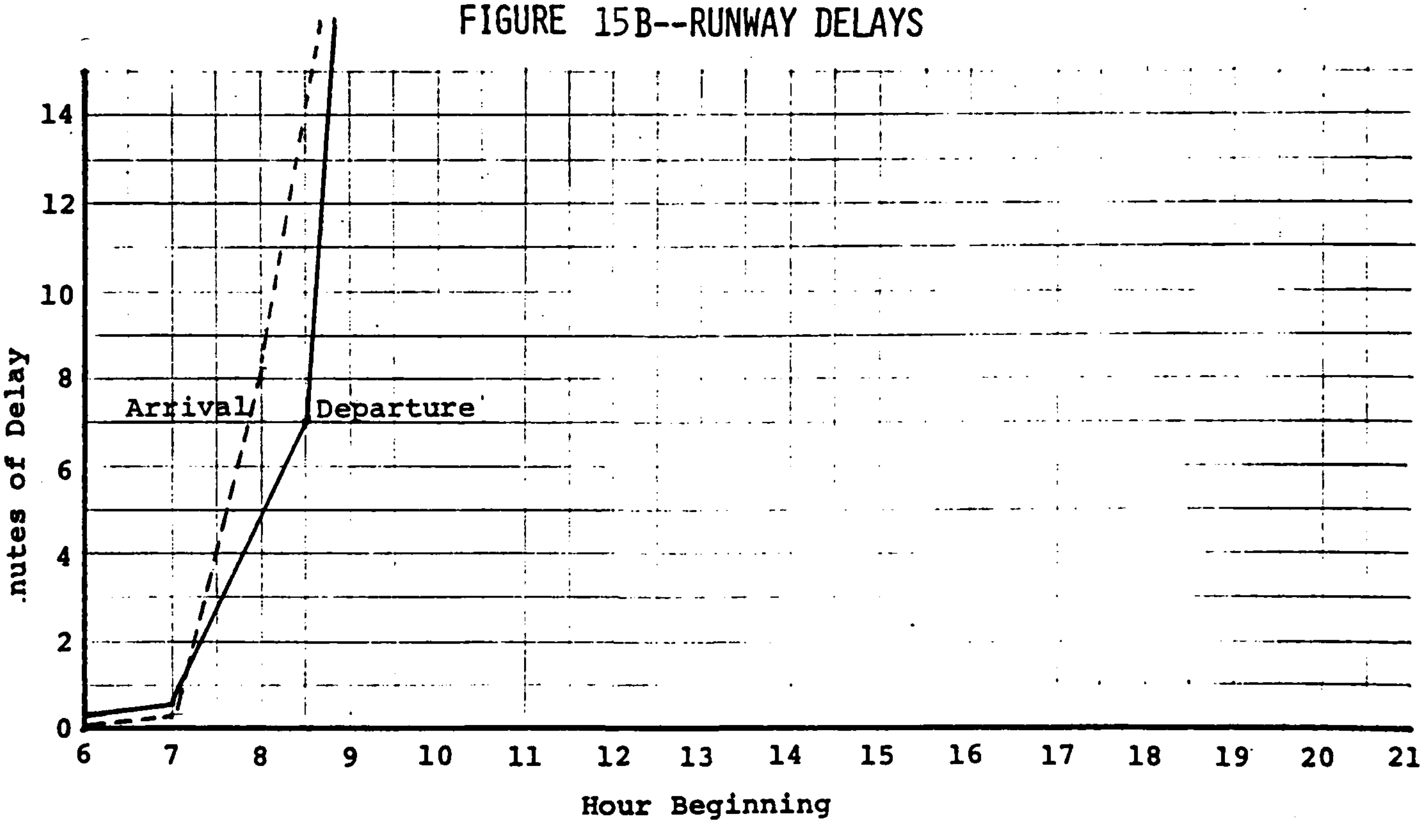


FIGURE 15B--RUNWAY DELAYS



Experiment No. 18

Objective:

To obtain 1985 baseline delay estimates for the following runway use in VFR 1 weather:

Arrival Runways	Departure Runways
17L-17R	17L-17R

Related Comparison Experiments:

Experiment 33 estimates the delay impact of an additional high speed exit from Runway 17L.

Results:

Figure 18A shows that total aircraft flows vary from 29 to 119 aircraft per hour over the 16 hour simulation run. The peak hour is from 1100 to 1200 hours and contains 61 arrival aircraft and 58 departure aircraft.

Figure 18B shows that average delays to aircraft using the runways are as high as 5.5 minutes per aircraft. Peak hour average delays are 5.0 minutes for arrival aircraft and 1.6 minutes for departure aircraft.

FIGURE 18A--RUNWAY FLOW RATES

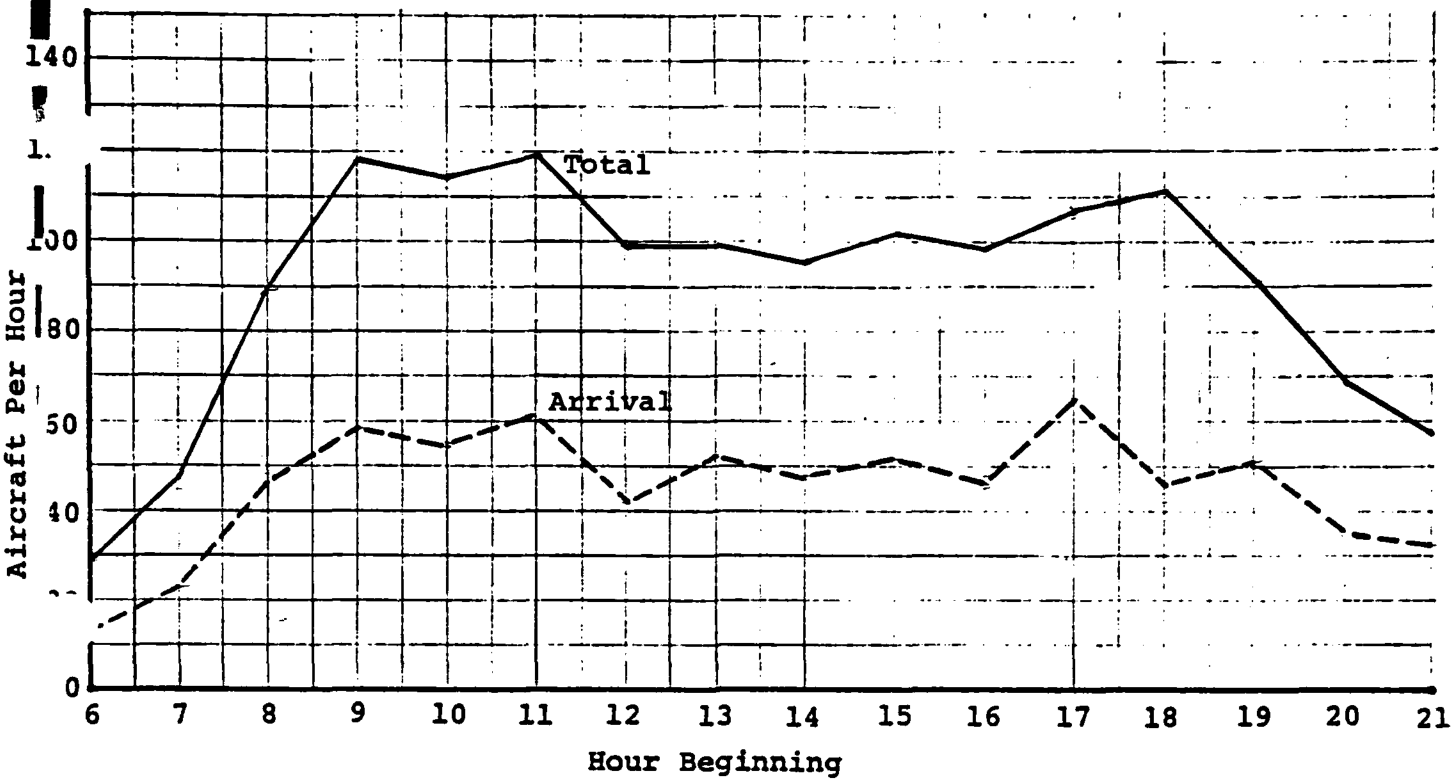
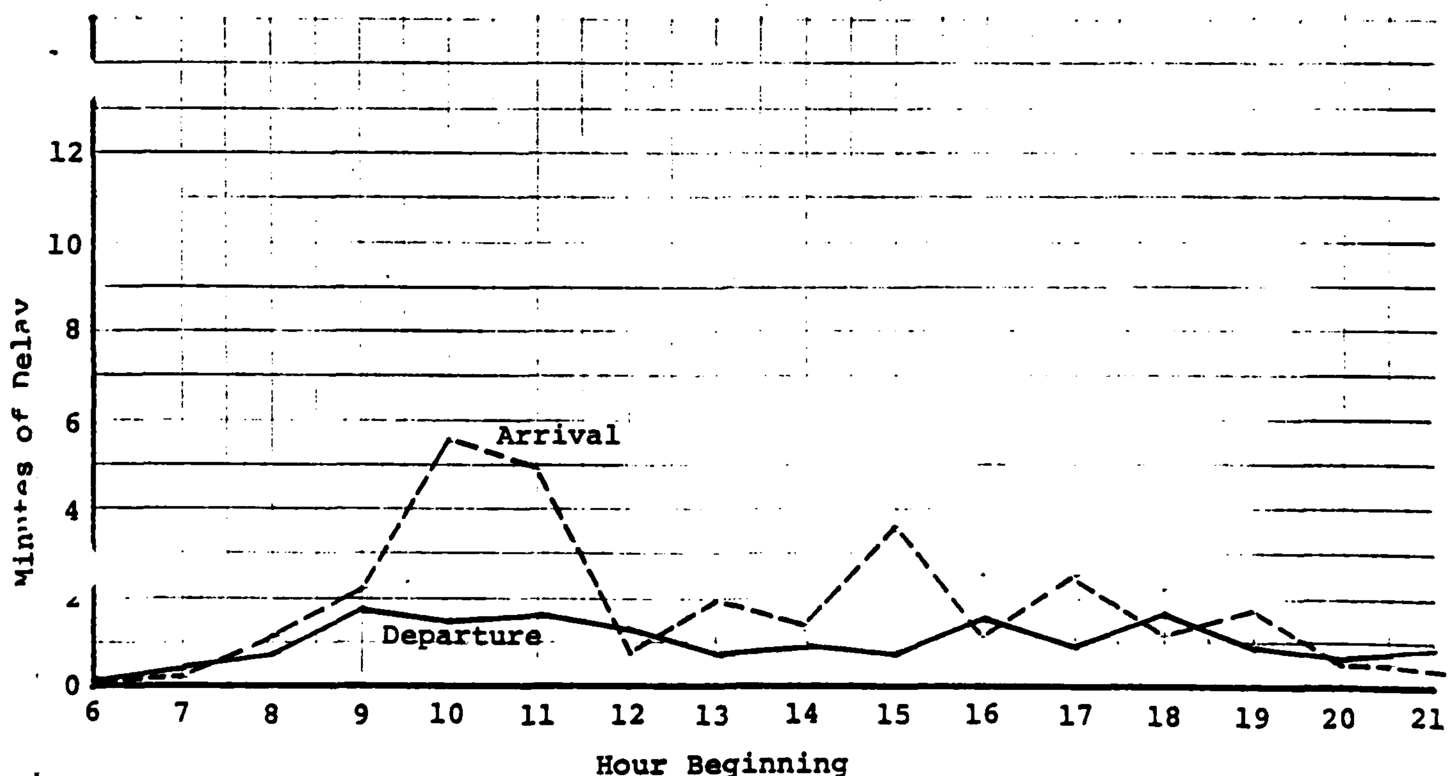


FIGURE 18B--RUNWAY DELAYS



Experiment No. 29

Objective:

To estimate the delay impact of the availability of Runway 8L for all jet departures (due to runway extension and/or low temperatures).

Related Comparison Experiments:

Experiment 4 is the 1985 baseline for the comparison.

Results:

Figure 29A shows that total aircraft flows vary from 27 to 115 aircraft per hour over the 16 hour simulation run. The peak hour is from 1000 to 1100 hours and contains 56 arrival aircraft and 59 departure aircraft.

Figure 29B shows that average delays to aircraft using the runways are as high as 3.2 minutes per aircraft. Peak hour average delays are 3.2 minutes for arrival aircraft and 0.9 minutes for departure aircraft.

Figure 29C shows that average delays to aircraft using the taxiways are negligible.

Figure 29D shows that average aircraft taxi travel times vary from 1.3 to 4.4 minutes. Peak hour average taxi travel times are 3.8 minutes for arrival aircraft and 4.0 minutes for departure aircraft.

Comparison of these flows and delays with the corresponding flows and delays estimated in Experiment 4 shows that small savings in departure delays can be obtained with the availability of 8L for jet departures. These savings are small because delays were also small in the baseline case.

FIGURE 29A--RUNWAY FLOW RATES

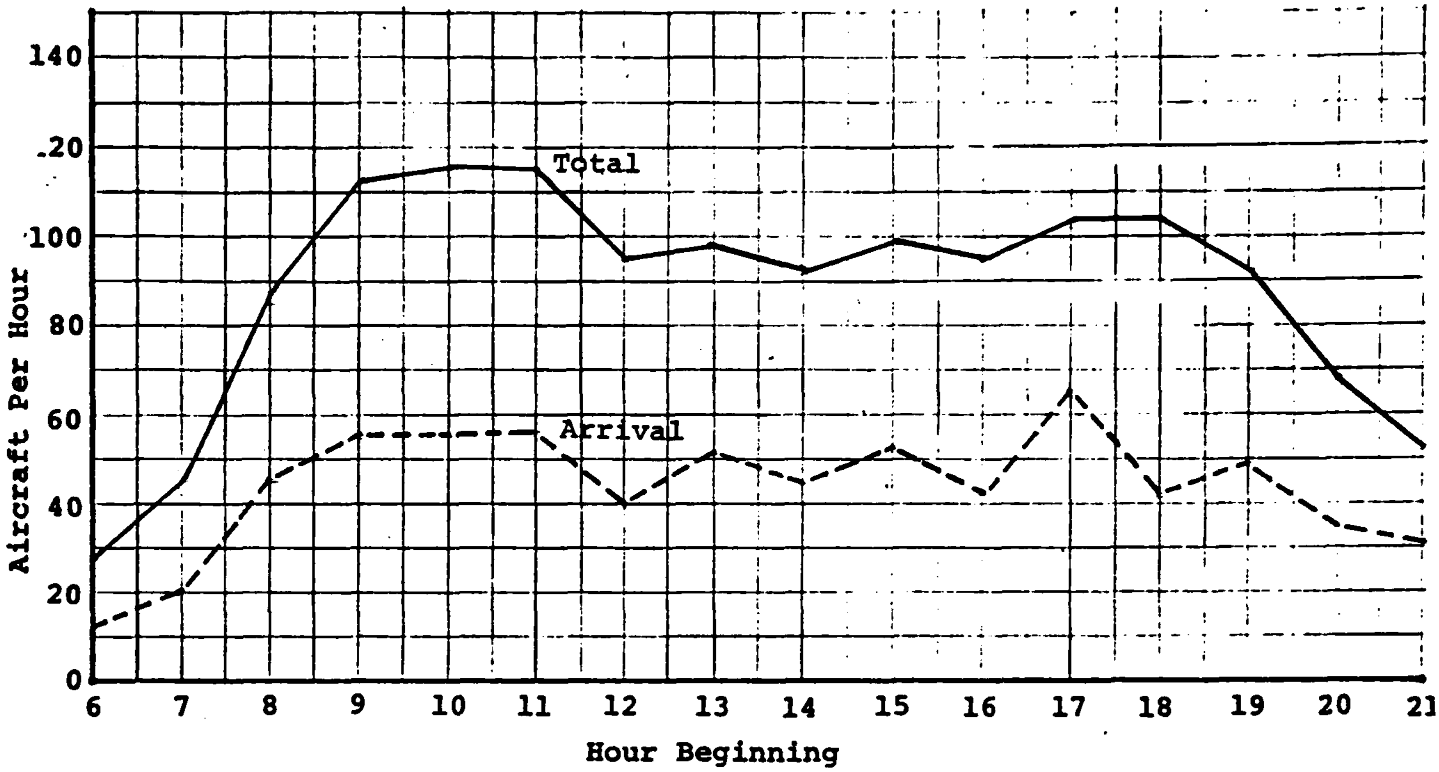


FIGURE 29B--RUNWAY DELAYS

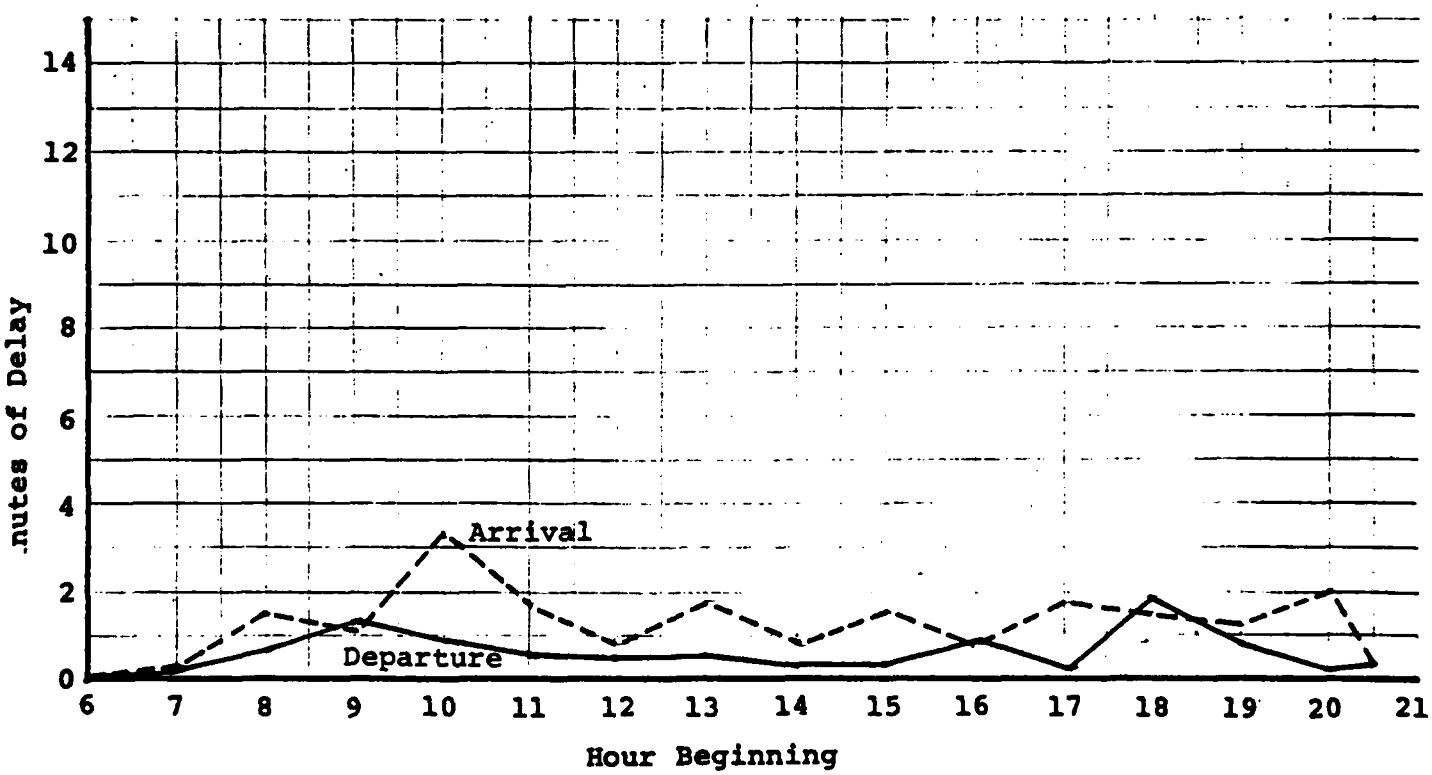


FIGURE 29C--TAXIWAY DELAYS

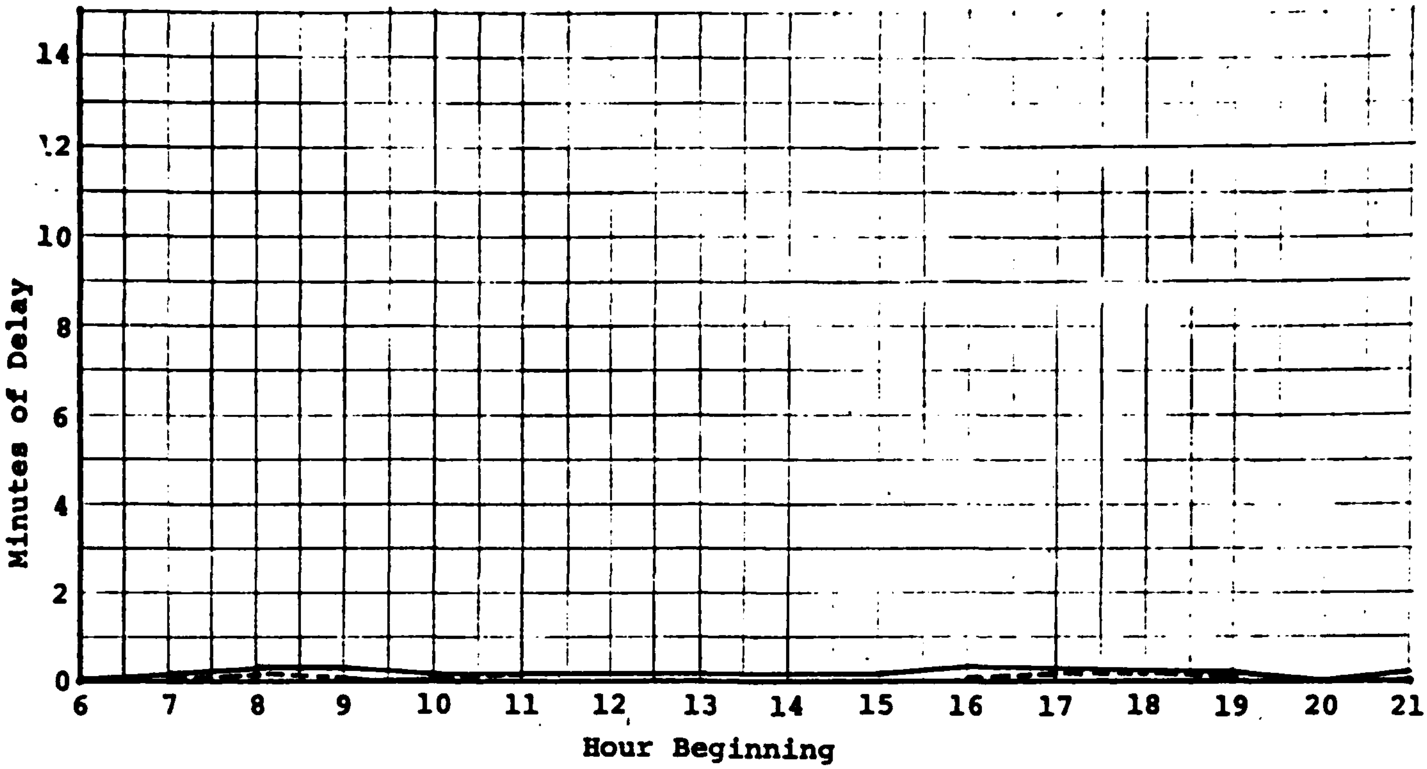
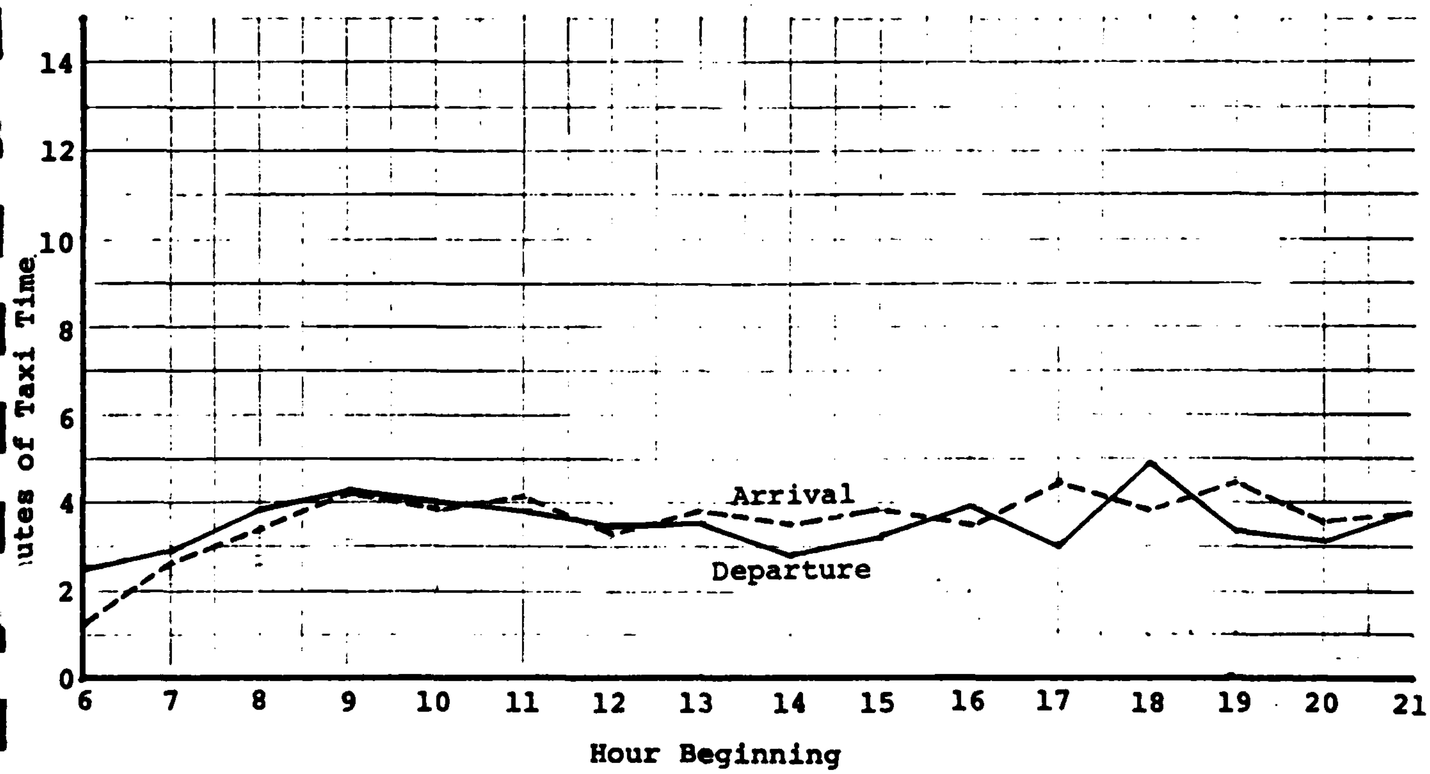


FIGURE 29D--TAXIWAY TRAVEL TIMES



Experiment No. 30

Objective:

To estimate the delay impact of the absence of an extension of taxiway D between D2 and D2.

Related Comparison Experiments:

Experiment 29 is the 1985 basis for comparison.

Results:

Figure 30A shows that total aircraft flows vary from 27 to 115 aircraft per hour over the 16 hour simulation run. The peak hour is from 1000 to 1100 hours and contains 56 arrival aircraft and 59 departure aircraft.

Figure 30B shows that average delays to aircraft using the runways are as high as 3.4 minutes per aircraft. Peak hour average delays are 3.4 minutes for arrival aircraft and 0.9 minutes for departure aircraft.

Figure 30C shows that average delays to aircraft using the taxiways are negligible.

Figure 30D shows that average aircraft taxi travel times vary from 1.4 to 5.1 minutes. Peak hour average taxi travel times are 3.9 minutes for arrival aircraft and 4.3 minutes for departure aircraft.

Comparison of these data with corresponding data estimated in Experiment 29 shows that delays and travel times increase slightly when the extension of Taxiway D is absent. In both cases, delays and travel times are relatively low.

FIGURE 30A--RUNWAY FLOW RATES

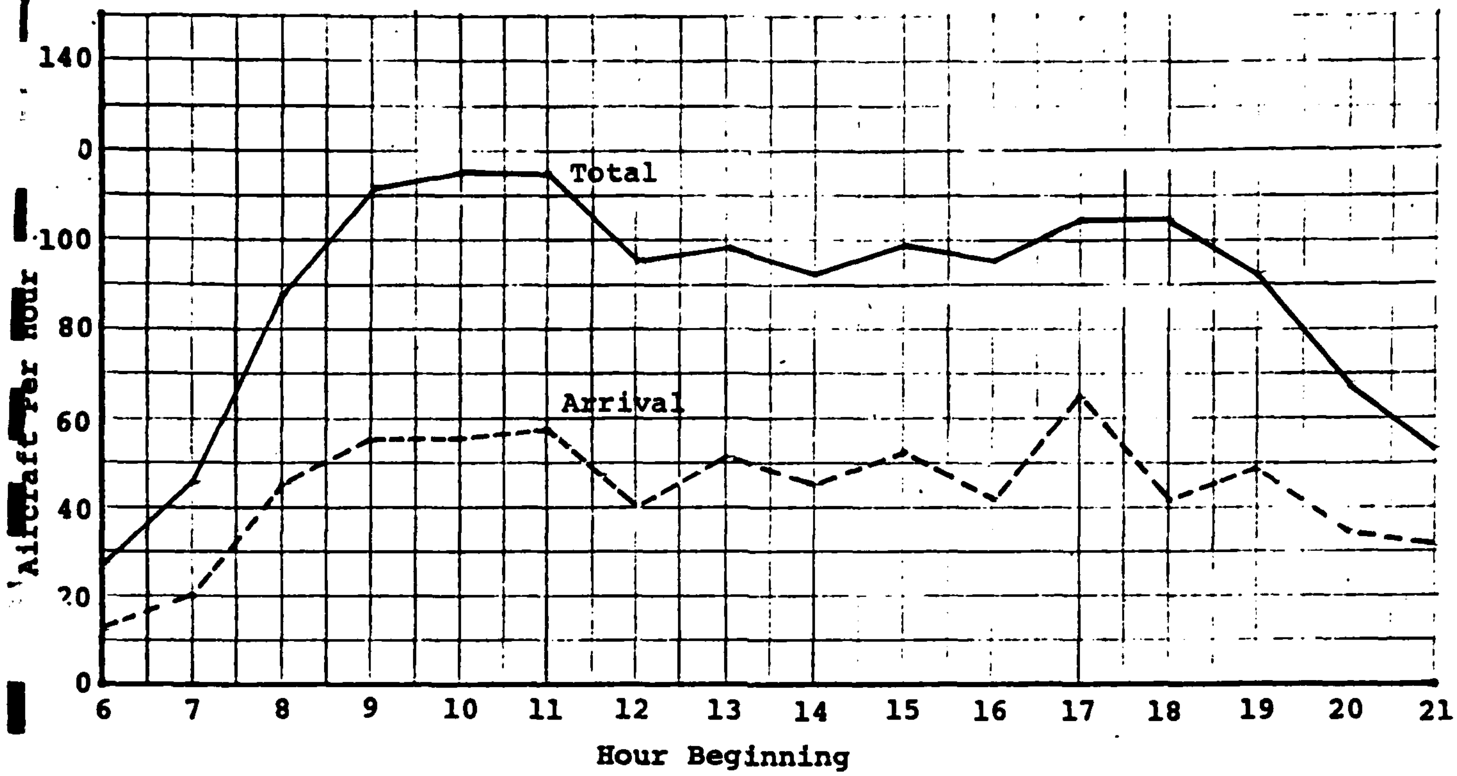


FIGURE 30B--RUNWAY DELAYS

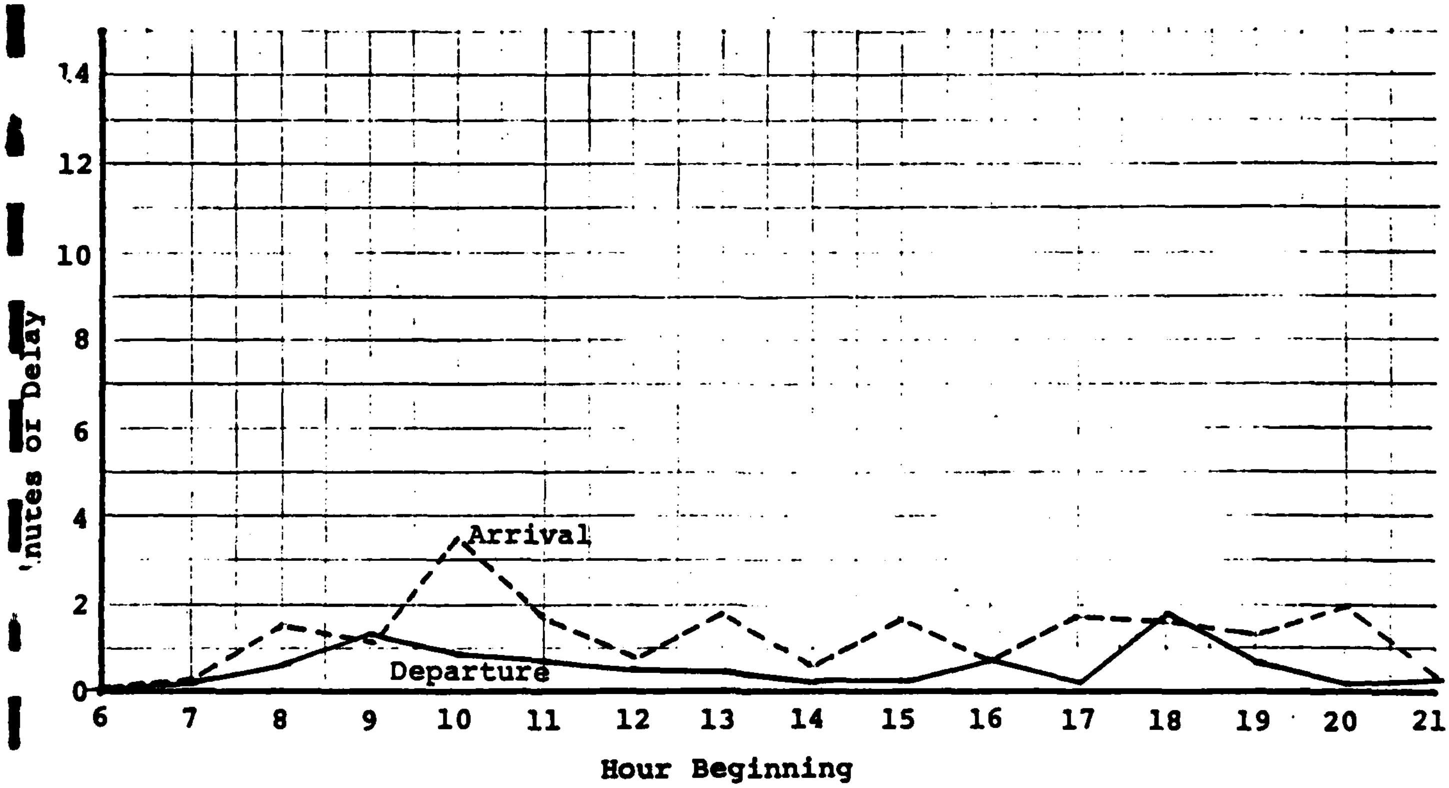


FIGURE 30C--TAXIWAY DELAYS

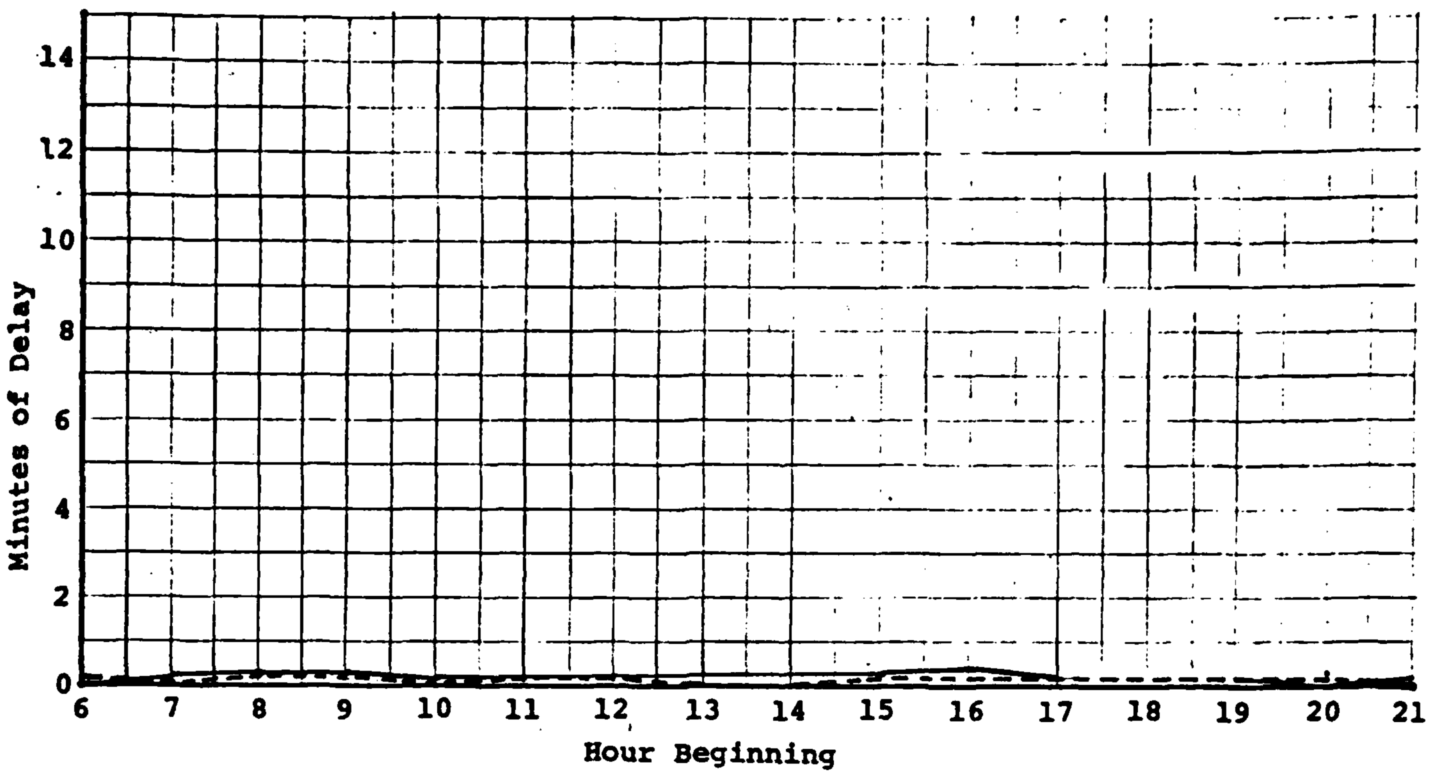
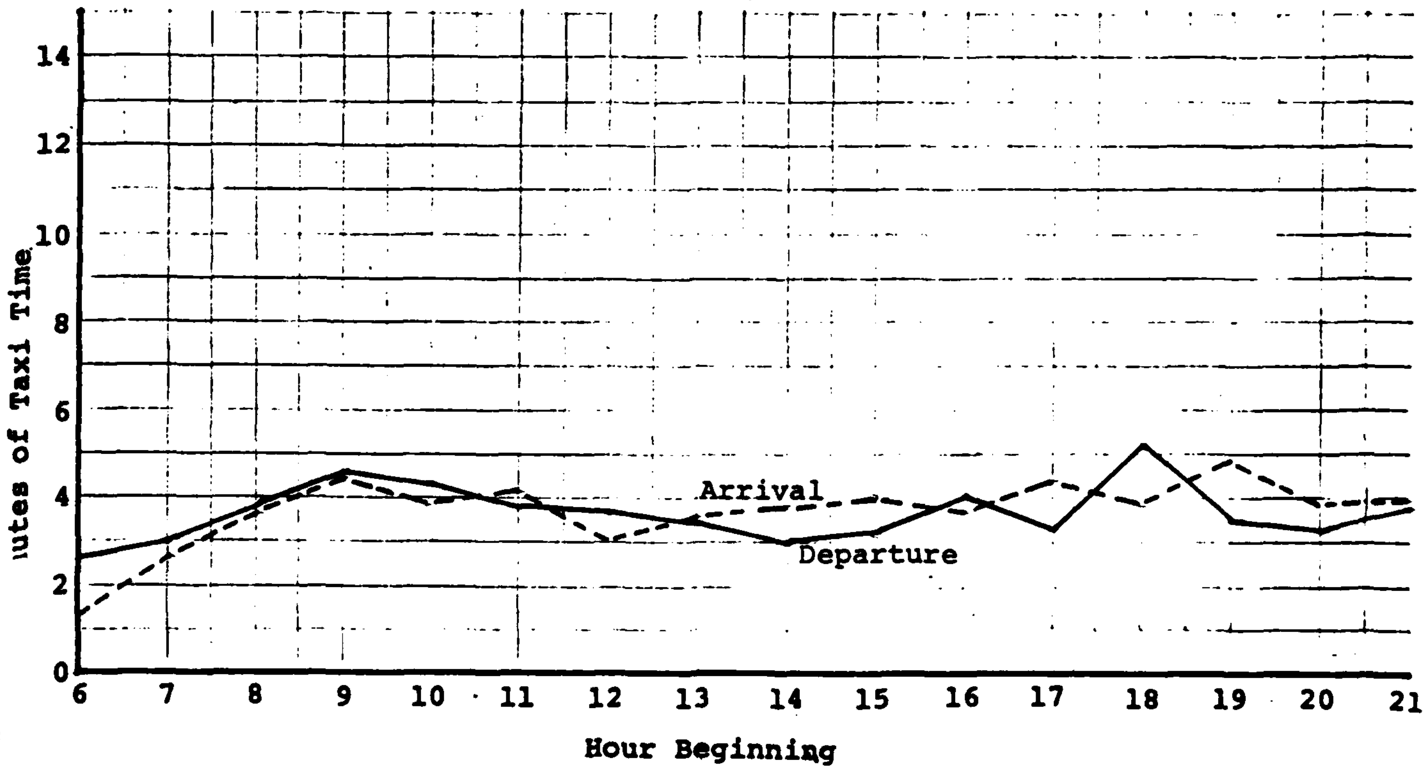


FIGURE 30D--TAXIWAY TRAVEL TIMES



Experiment No. 31

Objective:

To estimate the delay impact of the implementation of ASDE in IFR 2 conditions with the following runway use:

Arrival Runway	Departure Runway
35R	35L

Related Comparison Experiments:

Experiment 15 is the 1985 baseline for comparison.

Results:

As for Experiment 15, this experiment was performed for the six hours between 0600 and 1200 hours. By 1200 hours arrival delays were in excess of 2.5 hours and the run was stopped. The high delays are due to an excess of demand over capacity.

Figure 31A shows that total aircraft flows vary from 8 to 64 aircraft per hour over the 16 hour simulation run. The peak hour is from 0900 to 1000 hours and contains 33 arrival aircraft and 31 departure aircraft.

Figure 31B shows that average delays to aircraft using the runways are as high as 150 minutes per aircraft. Average delays reach 150 minutes for arrival aircraft and 82 minutes for departure aircraft.

Comparison of these flows and delays with the runway flows and delays for Experiment 15 shows that the implementation of ASDE results in a reduction in delays of up to 4 minutes per aircraft.

FIGURE 31A--RUNWAY FLOW RATES

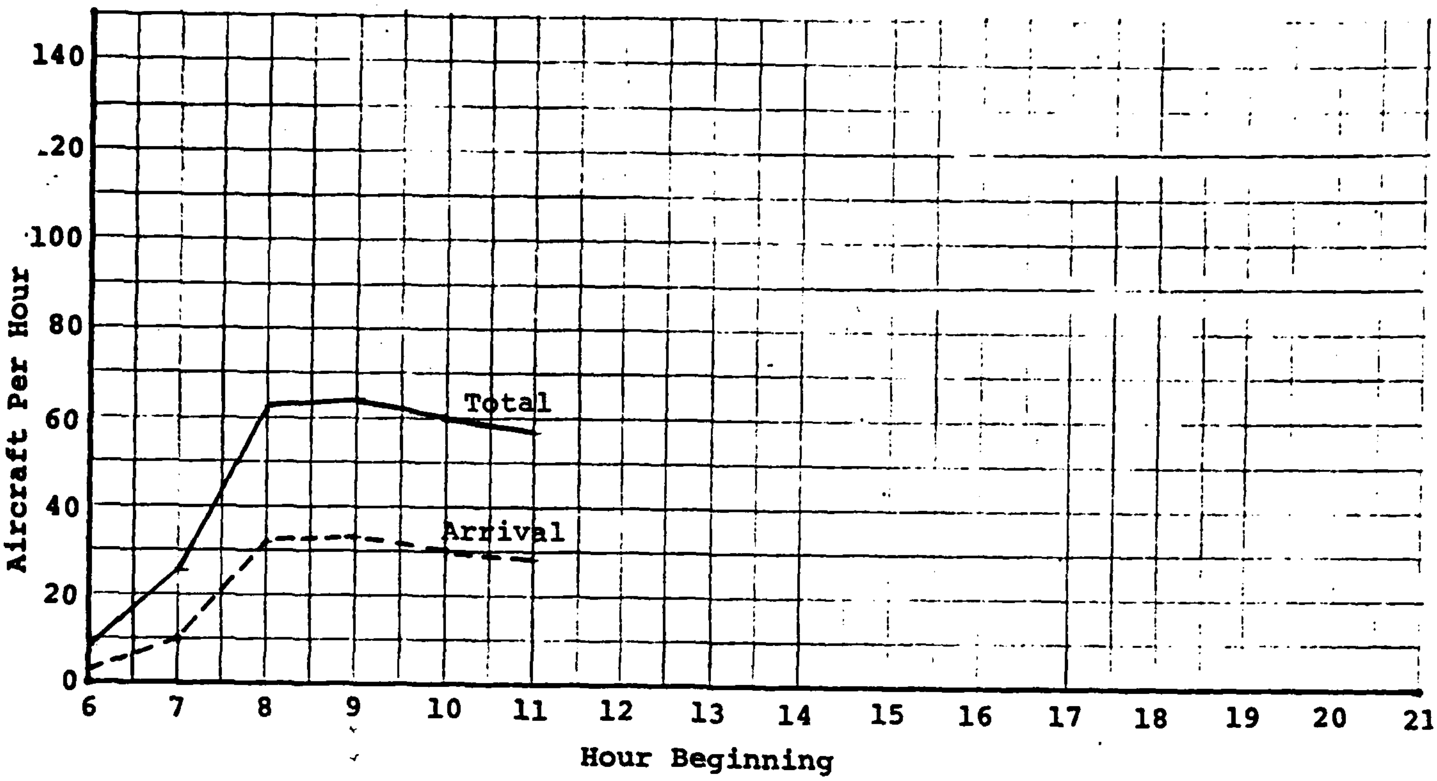
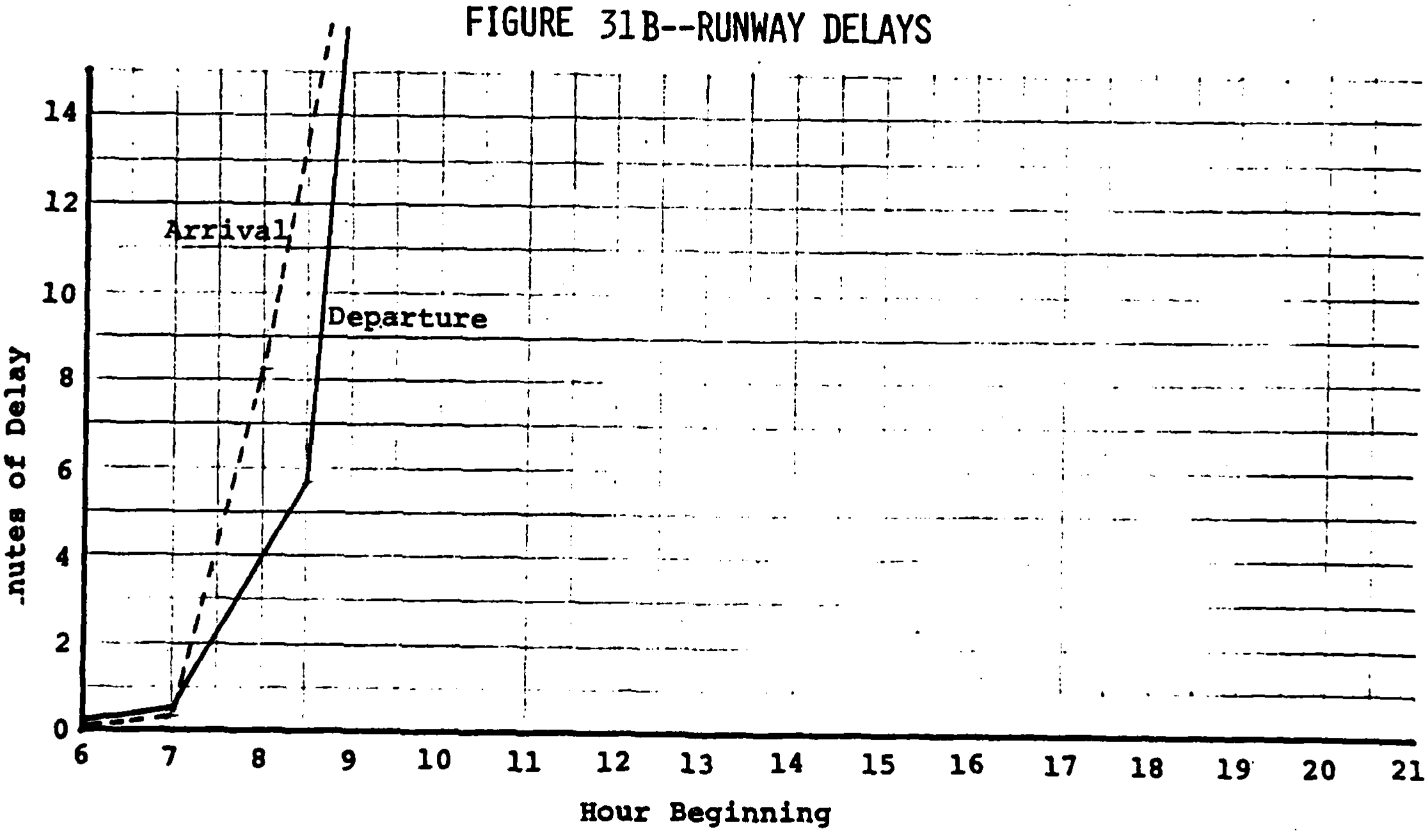


FIGURE 31B--RUNWAY DELAYS



Experiment No. 33

Objective:

To estimate the delay impact of an additional high speed exit on Runway 17L in VFR 1 weather with the following runway use:

Arrival Runways	Departure Runways
17L-17R	17L-17R

Related Comparison Experiments:

Experiment 18 is the 1985 baseline for comparison.

Results:

Figure 33A shows that total aircraft flows vary from 29 to 121 aircraft per hour over the 16 hour simulation run. The peak hour is from 1100 to 1200 hours and contains 63 arrival aircraft and 58 departure aircraft.

Figure 33B shows that average delays to aircraft using the runways are as high as 5.5 minutes per aircraft. Peak hour average delays are 4.9 minutes for arrival aircraft and 1.4 minutes for departure aircraft.

Comparison of these flows and delays with the runway flows and delays for Experiment 18 shows that an additional high speed exit on Runway 17L results in a slight reduction in delays to aircraft.

FIGURE 33A--RUNWAY FLOW RATES

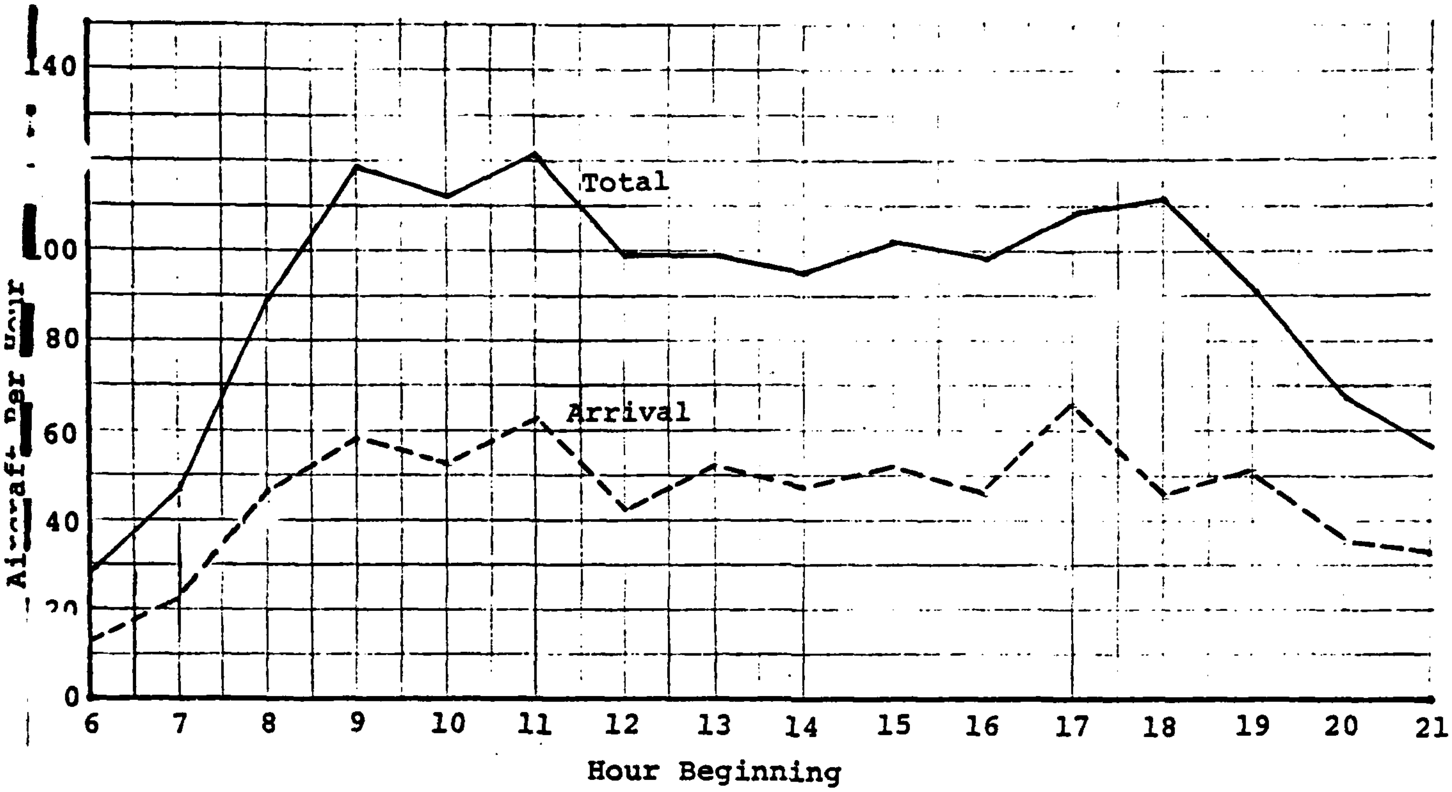
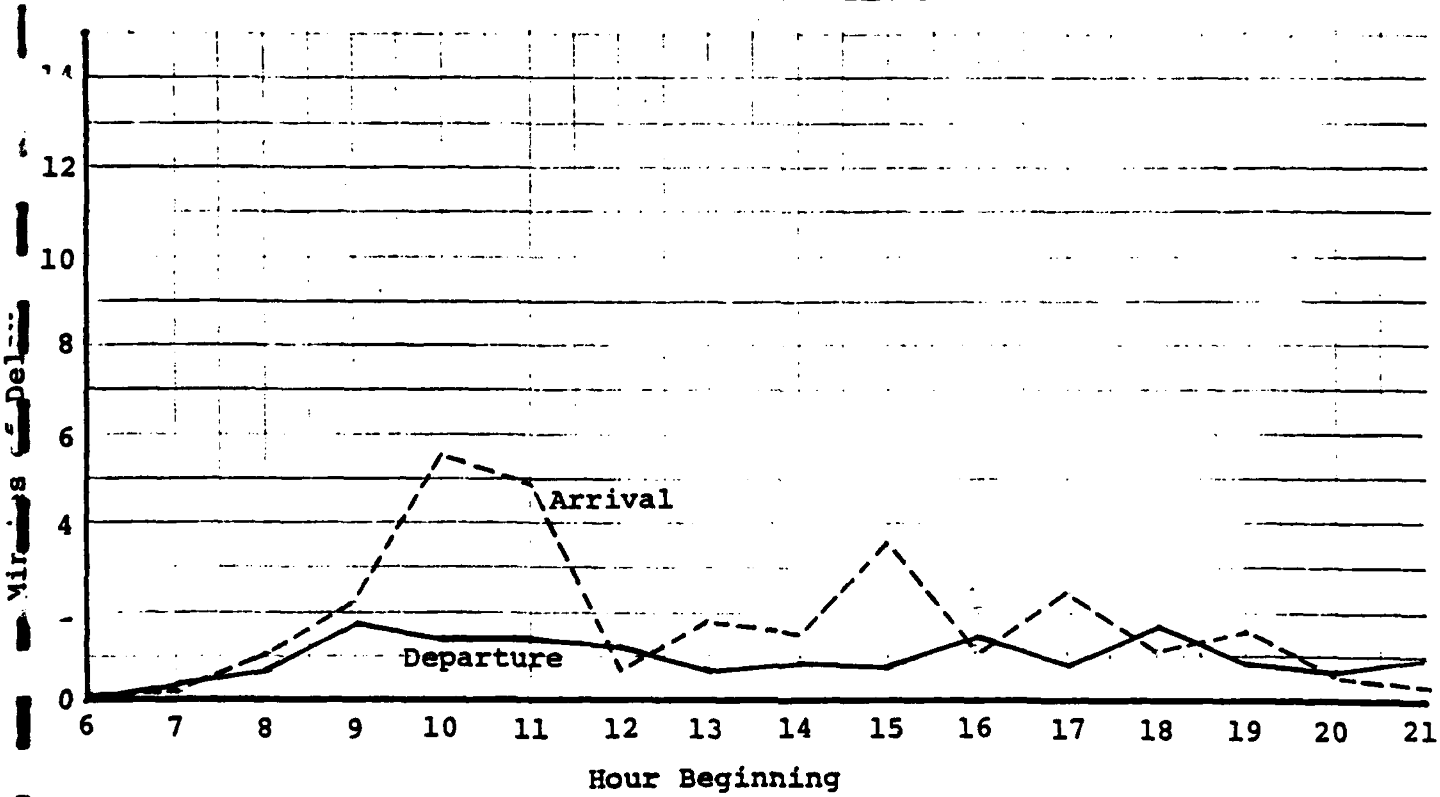


FIGURE 33B--RUNWAY DELAYS



Attachment B

STAGE 1 DELAY EXPERIMENTS: INPUT DATA REVISIONS

STAPLETON INTERNATIONAL AIRPORT

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.

August 1978

Attachment B

STAGE 1 DELAY EXPERIMENTS: INPUT DATA REVISIONS

This attachment documents the major revisions to input data from the data shown in Data Package No. 3.

1. Aircraft separations were revised to reflect FAA Report No. FAA-EM-78-8A. Revised separations are given below.

   (a) 1978 VFR Separations

   Arrival-Arrival Separation (n.m.)

		Trail Aircraft Class			
		A	B	C	D
Lead	A	2.7	3.0	3.2	3.2
Aircraft	B	2.7	3.0	3.2	3.2
Class	C	3.5	3.8	3.2	3.2
	D	5.3	5.6	4.9	4.0

   Departure-Departure Separation (seconds)

		Trail Aircraft Class			
		A	B	C	D
Lead	A	35	35	45	50
Aircraft	B	35	35	45	50
Class	C	50	50	60	60
	D	120	120	120	90

   (b) 1978 IFR Separations

   Arrival-Arrival Separation (n.m.)

		Trail Aircraft Class			
		A	B	C	D
Lead	A	3.7	3.9	4.1	4.1
Aircraft	B	3.7	3.9	4.1	4.1
Class	C	4.7	4.9	4.1	4.1
	D	6.7	6.9	6.1	5.1

   Departure-Departure Separation (seconds)

		Trail Aircraft Class			
		A	B	C	D
Lead	A	60	60	60	60
Aircraft	B	60	60	60	60
Class	C	60	60	60	60
	D	120	120	120	90

(c) 1985 VFR Separations

Arrival-Arrival Separations (n.m.)

		Trail Aircraft Class			
		A	B	C	D
Lead Aircraft Class	A	2.6	2.9	3.0	3.0
	B	2.6	2.9	3.0	3.0
	C	3.4	3.7	3.0	3.0
	D	4.7	5.0	4.1	3.8

Departure-Departure separations (seconds)

		Trail Aircraft Class			
		A	B	C	D
Lead Aircraft Class	A	35	35	45	50
	B	35	35	45	50
	C	50	50	60	60
	D	120	120	120	90

(d) 1985 IFR Separations

Arrival-Arrival Separation (n.m.)

		Trail Aircraft Class			
		A	B	C	D
Lead Aircraft Class	A	3.7	4.0	4.1	4.1
	B	3.7	4.0	4.1	4.1
	C	3.7	4.0	4.1	4.1
	D	4.7	5.0	4.1	4.1

Departure-Departure Separations (seconds)

		Trail Aircraft Class			
		A	B	C	D
Lead Aircraft Class	A	60	60	60	60
	B	60	60	60	60
	C	60	60	60	60
	D	120	120	120	90

2. Aircraft demand schedules were revised to reflect the correct hourly distribution of traffic and to correct errors in interpretation of the Speas forecast. Revised demand schedules are given in updated Tables 3 and 4. Revised hourly distribution of traffic is given below.

Hour	% daily traffic	Hour	% daily traffic	Hour	% daily traffic	Hour	% daily traffic
00-01	1.6	06-07	3.1	12-13	7.2	18-19	6.9
01-02	0.9	07-08	3.5	13-14	7.1	19-20	4.9
02-03	0.1	08-09	5.4	14-15	6.2	20-21	3.8
03-04	0.5	09-10	7.0	15-16	5.5	21-22	2.6
04-05	0.5	10-11	6.7	16-17	5.8	22-23	2.8
05-06	2.2	11-12	6.6	17-18	6.4	23-24	2.7

Table 3

AIRCRAFT DEMAND: EXPERIMENT NUMBER 1 (1978 DEMAND)
Stapleton International Airport
Stage I Experiments: Input Data

			General Aviation			
Time Period	air carrier	air taxi	turbo engine	multiengine piston	single-engine piston	Total aircraft operations
0600-0700	12	7	9	11	11	50
0700-0800	16	9	9	12	11	57
0800-0900	42	13	9	12	11	87
0900-1000	69	11	9	12	12	113
1000-1100	62	13	9	12	12	108
1100-1200	64	12	8	11	11	106
1200-1300	58	20	10	14	14	116
1300-1400	71	8	9	13	13	114
1400-1500	49	14	10	14	13	100
1500-1600	42	10	10	13	13	88
1600-1700	45	14	9	13	12	93
1700-1800	62	10	8	12	11	103
1800-1900	74	13	6	9	9	111
1900-2000	46	11	5	8	8	78
2000-2100	37	7	5	6	6	61
2100-2200	21	4	5	6	5	41
	770	176	130	178	172	1,426

Table 4

AIRCRAFT DEMAND: EXPERIMENT NUMBER 4 (1985 DEMAND)
Stapleton International Airport
Stage I Experiments: Input Data

Time period	air carrier	air taxi	General aviation: turbo engine	General aviation: multiengine piston	General aviation: single-engine piston	Total aircraft operations
0600-0700	6	4	6	8	8	32
0700-0800	16	9	6	8	8	47
0800-0900	58	11	6	8	8	91
0900-1000	79	14	6	9	8	116
1000-1100	79	14	7	10	10	120
1100-1200	79	12	6	9	9	115
1200-1300	55	16	7	9	9	96
1300-1400	66	12	6	9	8	101
1400-1500	51	15	7	10	10	93
1500-1600	67	11	7	9	9	103
1600-1700	58	12	7	9	9	95
1700-1800	76	12	6	8	7	109
1800-1900	79	12	4	6	6	109
1900-2000	67	11	4	5	5	92
2000-2100	48	9	3	4	4	68
2100-2200	37	8	3	4	4	56
16 hour total	921	184	91	125	122	1,443
Comparable 16 hour 1990 totals	1,061	209	88	121	118	1,597

Attachment C

SUGGESTED STAGE 2 DELAY EXPERIMENTS

STAPLETON INTERNATIONAL AIRPORT

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.

August 1978

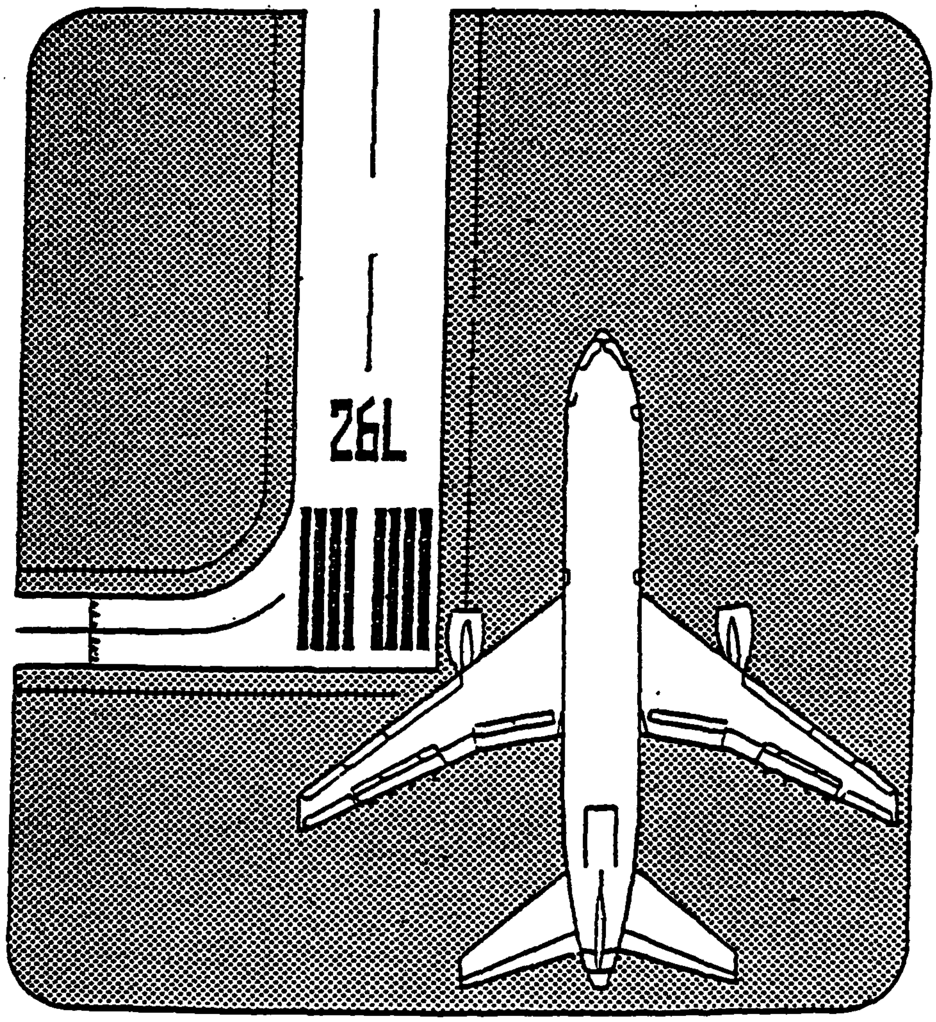
SUGGESTED
STAGE 2 EXPERIMENTS

Experiment number	Model	Arrival runways	Departure runways	Weather	Demand	ATC scenario	Near-term improvements
35	ASM	35L-35R	35L-35R	IFR2	1985	1985	Simultaneous ILS
36	ASM	25-26L-26R	35L-35R	VFR1	1990	1990	1990 Baseline
37	ASM	26L	35L	IFR1	1990	1990	1990 Baseline
45	ASM	25-26L-26R	35L-35R	VFR1	1990	1990	Cancel Prohibited Area P-26
61	ASM	25-26L-26R	35L-35R	VFR1	1985	1978	1978 GA Demand
62	ASM	25-26L-26R	35L-35R	VFR1	1990	1978	1978 GA Demand
63	ASM	25-26L-26R	35L-35R	VFR1	1990	1990	Increase Commuters 100%
51	ADM	n.a.	n.a.	n.a.	1985	1985	1985
52	ADM	n.a.	n.a.	n.a.	1985	1985	1978
53	ADM	n.a.	n.a.	n.a.	1985	1978	1985
54	ADM	n.a.	n.a.	n.a.	1985	1978	1978
55	ADM	n.a.	n.a.	n.a.	1990	1990	1990
56	ADM	n.a.	n.a.	n.a.	1990	1990	1978
57	ADM	n.a.	n.a.	n.a.	1990	1978	1990
58	ADM	n.a.	n.a.	n.a.	1990	1978	1978

STAPLETON INTERNATIONAL AIRPORT

DATA PACKAGE NO.5

AIRPORT IMPROVEMENT TASK FORCE DELAY STUDIES



prepared for

DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

under contract

DOT FA77WA-3961

PMM&Co. Peat, Marwick, Mitchell & Co.

SEPTEMBER 1978

PEAT, MARWICK, MITCHELL & CO.
P. O. BOX 8007
SAN FRANCISCO INTERNATIONAL AIRPORT
SAN FRANCISCO, CALIFORNIA 94128

Telephone: (415) 347-9521

September 11, 1978

Mr. Ray Fowler, AEM-100
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

Re: Input Data for Stapleton Delay Experiments

Dear Ray:

Enclosed is the input data package for Stapleton Stage 2 delay experiments (Attachment A) and a summary of average daily delays for the Stage 1 experiments (Attachment B). This data package should be reviewed at the Stapleton Task Force Sub-group meeting which is scheduled to take place on September 14, 1978.

Sincerely,

Stephen L. M. Hockaday
Manager

SLMH/nbe
Enclosure

cc: Mr. J. R. Dupree (ALG-312)
Mr. F. Jaeger (ARM-4)

Attachment A

STAGE 2 EXPERIMENTS: INPUT DATA PACKAGE

STAPLETON INTERNATIONAL AIRPORT

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.

September 1978

STAGE 2 EXPERIMENTS

Experiment Number	Model	Arrival Runways	Departure Runways	Weather	Demand	ATC Scenario	Near-Term Improvements
5	ASM	26L, 26R	35L, 35R	VFR1	1978	1978	Closure of Runway 7/25
35	ASM	35L, 35R	35L, 35R	IFR2	1985	1985	Simultaneous ILS Approaches 35L, 35R
36	ASM	25L, 26L, 26R	35L, 35R	VFR1	1990	1990	1990 Baseline
37	ASM	26L	35L	IFR1	1990	1990	1990 Baseline
39	ASM	25, 26L, 26R	35L, 35R	VFR1	1990	1990	Increase Air Carrier Demand by 10%
40 or 41	ASM	26L	35L, 35R	IFR1	1990	1990	± Air Carrier Demand by 10%
43	ASM	25, 26L, 26R	35L, 35R	VFR1	1990	1990	Reliever Airports-Reduce GA Demand by 50%
62	ASM	25, 26L, 26R	35L, 35R	VFR1	1990	1990	1978 GA Demand
64	ASM	26L	35L	IFR1	1985	1985	Reduce GA by 50%
65	ASM	34, 35R	34, 35L	IFR2	1985	1985	New 5000 ft N-S runway
51	ADM	n.a.	n.a.	n.a.	1985	1985	1985 Near-Term Improvements
52	ADM	n.a.	n.a.	n.a.	1985	1985	1978 Near-Term Improvements
53	ADM	n.a.	n.a.	n.a.	1985	1978	1985 Near-Term Improvements
54	ADM	n.a.	n.a.	n.a.	1985	1978	1978 Near-Term Improvements
55	ADM	n.a.	n.a.	n.a.	1990	1990	1990 Near-Term Improvements
56	ADM	n.a.	n.a.	n.a.	1990	1990	1978 Near-Term Improvements
57	ADM	n.a.	n.a.	n.a.	1990	1978	1990 Near-Term Improvements
58	ADM	n.a.	n.a.	n.a.	1990	1978	1978 Near-Term Improvements

INPUT DATA FOR EXPERIMENT NUMBER 5

Input data identical with Experiment 2 except:

1. No operations on Runway 25.
2. Revised arrival runway assignments are as follows:

Runway	Aircraft Class			
	A	B	C	D
26L	50%	50%	40%	100%
26R	50%	50%	60%	0%
	100%	100%	100%	100%

INPUT DATA FOR EXPERIMENT NUMBER 35

Input data identical with Experiment 15 except:

1. Arrivals and Departures can use both runways.

2. Operations on 35L and 35R are independent.

3. Revised runway assignments are as follows:

Runway	Aircraft Class			
	A	B	C	D
35L	50%	50%	50%	50%
35R	50%	50%	50%	50%
	100%	100%	100%	100%

INPUT DATA FOR EXPERIMENT NUMBER 36

a. LOGISTICS

1. Title: Stapleton International Airport Airfield Simulation Model: Stage I Experiments

2. Random Number Seeds: 2017, 3069, 4235, 5873, 6981, 7137, 8099, 9355, 0123, 1985.

3. Start and Finish Times: 0830 to 2100

4. Print Options: Summary run for ten random number seeds.

5. Airline Names:

Name	Code
Rocky Mountain	RM
Aspen	AS
United	UA
Braniff	BN
Western	WA
Continental	CO
Trans World	TW
Ozark	OZ
Delta	DL
North Central	NC
Texas International	TI
Frontier	FL
Third Level Carriers	TL

6. Processing Options: First run to check model input. Other runs in COMPUTE mode.

7. Truncation Limits: ± 3 standard deviations.

8. Time Switch: Not applicable.

b. AIRFIELD PHYSICAL CHARACTERISTICS

9. Airfield Network: See separate drawing.

10. Number of Runways: 5

11. Runway Identification: 26L, 26R, 35L, 35R, 25

12. Departure Runway End Links: 183, 113

13. Runway Crossing Links: 352, 346, 345, 344, 395, 400, 357, 356, 318, 321.

14. Exit Taxiway Location:

Runway	Taxiway	Link	Distance from Threshold (feet)
26L	B-4,C-6	489,353	5,800
	C-5	354	6,100
	C-4	356	7,400
	C-3	357	8,400
26R	D-2	318	5,000
	C-4	316	6,000
	C-3	311	6,900
	End	310	7,400
25	D-3	322	3,400

15. Holding Areas: Not applicable.

16. Airline Gates:

Airline	Airline Gate Area
Rocky Mountain	1
Aspen	1
United	2,3
Braniff	2
Western	3
Continental	3,4
Trans World	4
Ozark	4
Delta	4
North Central	5
Texas International	5
Frontier	5
Third Level Carrier	1

17. General Aviation Basing Areas:

Name	Base Area Code
Combs Aviation	GC
Beechcraft Aviation	GB
Atlas Aviation	GA

c. ATC PROCEDURES

18. Aircraft Separations:

Arrival-Arrival Separation (n.m.)

VFR

Lead Aircraft Class		Trail Aircraft Class A	B	C	D
	A	2.4	2.6	2.7	2.7
	B	2.4	2.6	2.7	2.7
	C	3.0	3.2	2.7	2.7
	D	3.5	3.7	3.3	2.8

IFR

Lead Aircraft Class		Trail Aircraft Class A	B	C	D
	A	2.5	2.7	2.8	2.8
	B	2.5	2.7	2.8	2.8
	C	3.0	3.2	2.8	2.8
	D	3.5	3.7	3.3	2.8

Departure-Departure Separations (seconds)

VFR

Lead Aircraft Class		Trail Aircraft Class A	B	C	D
	A	35	35	45	50
	B	35	35	45	50
	C	50	50	60	60
	D	60	60	60	60

IFR

Lead Aircraft Class		Trail Aircraft Class A	B	C	D
	A	60	60	60	60
	B	60	60	60	60
	C	60	60	60	60
	D	60	60	60	60

19. Route Data: See Figure 1.

20. Two-Way Path Data: Not applicable.

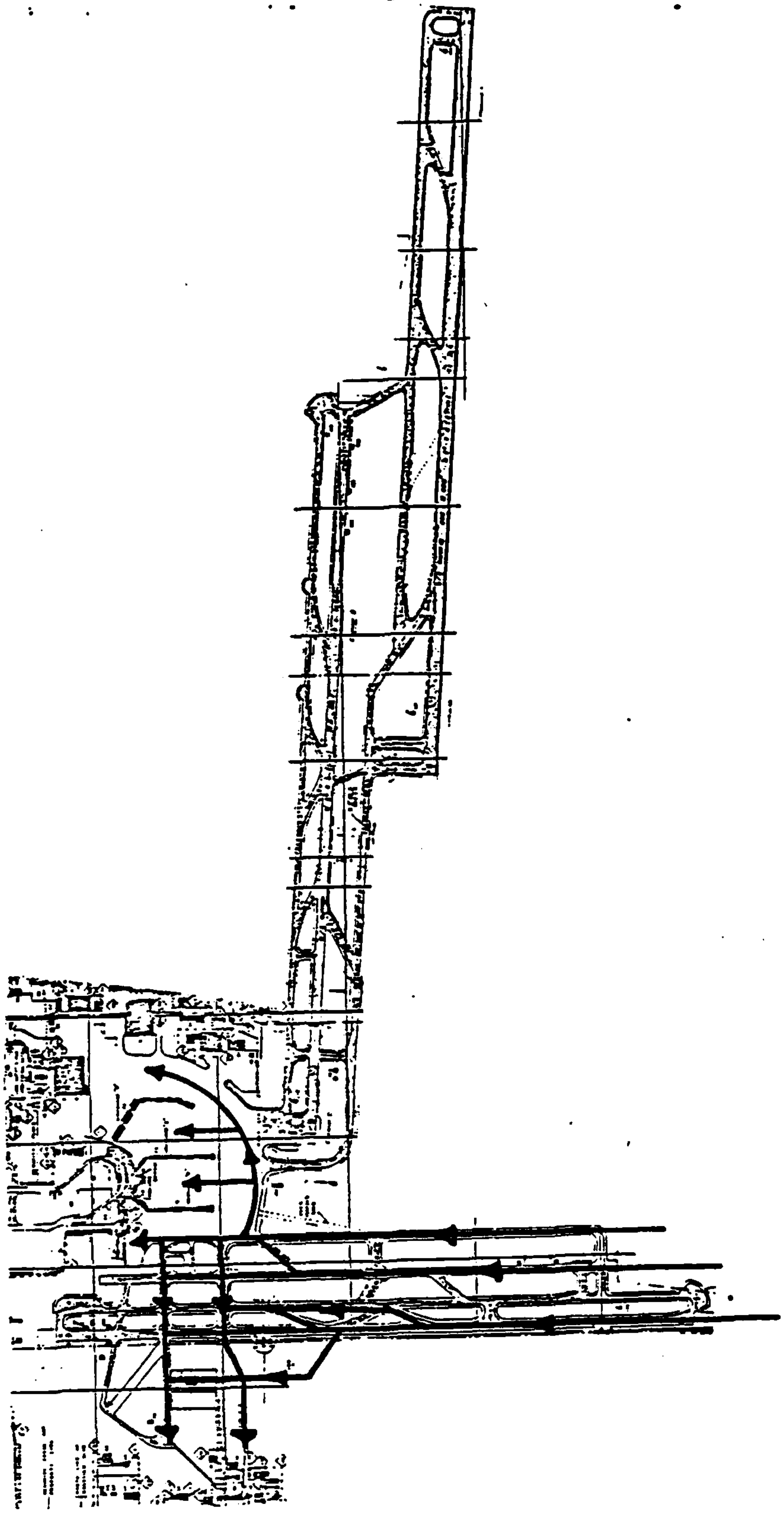


Figure 1
TAXIWAY ROUTES:
ARRIVALS ON RUNWAYS 25, 26L & 26R

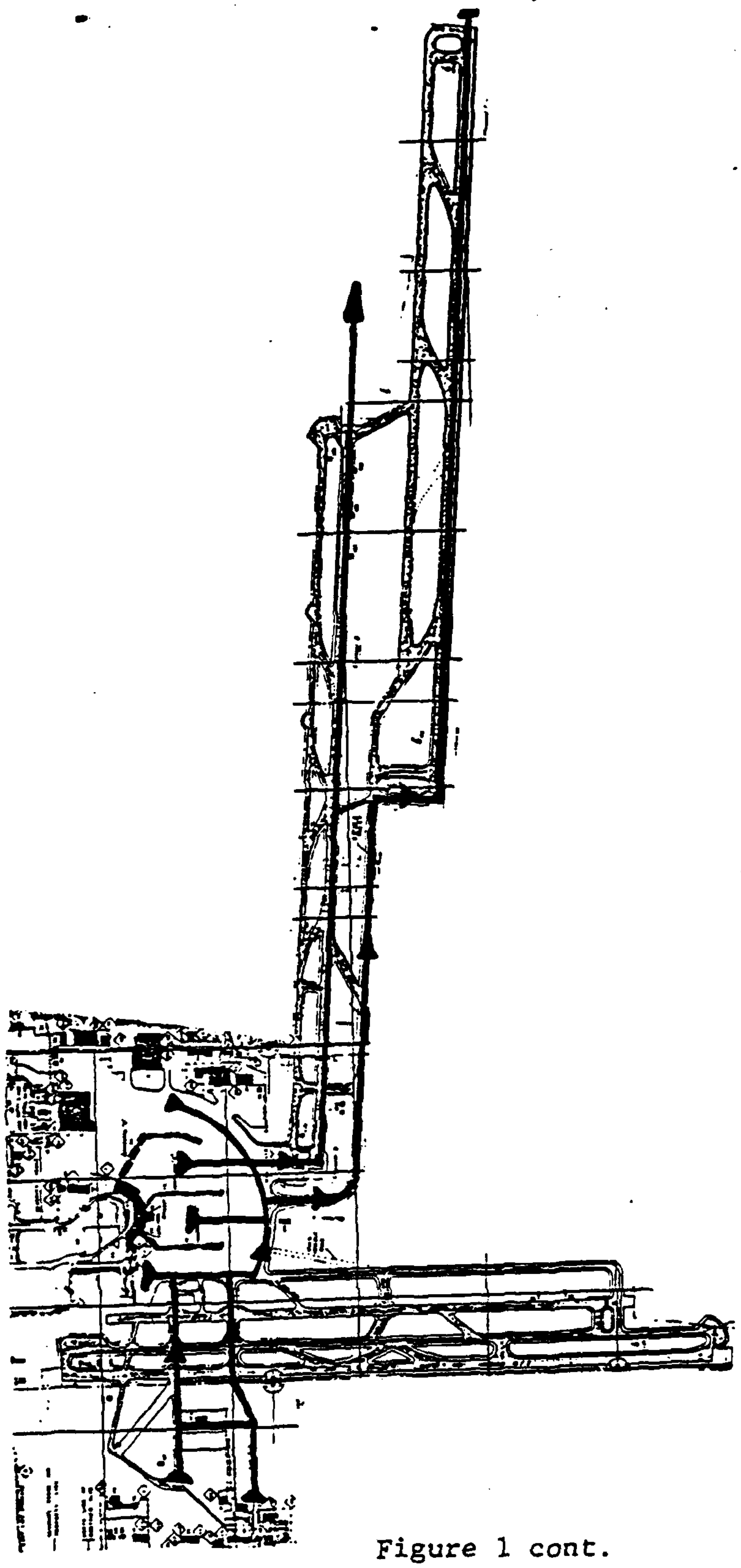


Figure 1 cont.
TAXIWAY ROUTES:
DEPARTURES ON RUNWAYS 35L & 35R

21. Common Approach Paths:

Arrival Runway	Aircraft Class	Length of Common Approach Path
25	A	1.0
26R	A	3.0
	B	3.0
	C	5.5
	D	5.5
26L	A	5.5
	B	5.5
	C	5.5
	D	5.5

22. Vectoring Delays:

This input normally allocates delays among vectoring and holding. With profile descent at Stapleton, holding occurs rarely, if ever.

Model input values will be used that preclude holding for arrival aircraft.

23. Departure Runway Queue Control:

Departure runway assignments will be made to balance departure queues where appropriate.

24. Gate Hold Control:

Hold aircraft at gate when departure queue at runway is 10 or more.

25. Departure Airspace Constraints:

Aircraft are not held at gate due to departure airspace constraints. Flow control constraints from other Centers do not normally occur.

26. Inter-Arrival Gap:

With this runway use, arrival aircraft are not delayed in the arrival airspace to release departures.

27. Runway Crossing Delay Control:

Arrival and departure runway operations are only interrupted for a taxiing aircraft to cross an active runway when the taxiing aircraft is delayed by 5 minutes or more.

d. AIRCRAFT OPERATIONAL CHARACTERISTICS

28. Exit Taxiway Utilization:

Exit Utilization (Percent)

	A/C Class	B-4 C-6	C-5	C-4	C-3
Runway 26L	A	100			
	B		54	15	31
	C		24	54	22
	D			50	50

	A/C Class	D-2	C-4	C-3	End
Runway 26R	A	100			
	B	44	17	39	
	C	32	47	21	
	D				100

	A/C Class	D-3
Runway 25	A	100
	B	100

29. Arrival Runway Occupancy Times:

Runway Occupancy Time (Seconds)

	A/C Class	B-4 C-6	C-5	C-4	C-3
Runway 26L	A	60			
	B		45	60	70
	C		41	54	58
	D			51	60

	A/C Class	D-2	C-4	C-3	End
Runway 26R	A	55			
	B	36	49	61	
	C	31	47	55	
	D				60

	A/C Class	D-3
Runway 25R	A	45
	B	40

30. Touch & Go Occupancy Times:

Aircraft Class	Runway Occupancy Time (Seconds)	
	Mean	Standard Deviation
A	22	3
B	23	3
C	27	4
D	27	4

31. Departure Runway Occupancy Times:

Aircraft Class	Runway Occupancy Time (seconds)	
	Mean	Standard Deviation
A	23	3
B	26	3
C	37	4
D	37	4

32. Taxi Speeds: 5-30 mph depending on location.

33. Approach Speeds:

Aircraft Class	Approach Speed (Knots)	
	Mean	Standard Deviation
A	100	10
B	135	10
C	155	10
D	160	10

34. Gate Service Times: Not applicable.

35. Airspace Travel Times: See Table 1.

36. Runway Crossing Times:

Aircraft Class	Runway Crossing Time (Seconds)
A	12
B	14
C	17
D	20

Table 1

AIRSPACE TRAVEL TIMES[a]
(minutes)
Stapleton International Airport
Stage 2 Experiments: Input Data

Fisc	Aircraft Class	Travel time to runways 8L/8R	17L/17R	26L/26R	35L/35R
KIOWA	1, 2	15	16	12	12
	3	18	19	14	14
	4	25	26	20	20
KEANN	1, 2	16	13	12	17
	3	19	15	14	20
	4	26	21	20	28
DRAKO	1, 2	14	11	16	17
	3	16	13	18	20
	4	23	19	26	28
BYSON	1, 2	13	16	16	13
	3	15	19	19	15
	4	21	27	27	21
"Pop-ups"	3	8	8	8	8
	4	9	9	9	9

a. Nominal (undelayed) travel times.

37. <u>Lateness Distribution</u>: See Table 2.

38. <u>Demand</u>: See Table 3.

Table 2

ARRIVAL AIRCRAFT LATENESS DISTRIBUTION
(Average deviation from schedule, excluding delays due to destination airport)

Amount of time late or early	Percent of flights late or early (%)
More than 15 min. early	0
less than 15 min. early	5
On time	24
less than 5 minutes late	29
5 to 10 minutes late	15
10 to 15 minutes late	9
15 to 30 minutes late	9
30 to 45 minutes late	4
45 to 60 minutes late	2
more than 60 minutes late	3

Source: Peat, Marwick, Mitchell & Co., analysis of data provided by Stapleton Task Force.

Table 3

AIRCRAFT DEMAND: EXPERIMENT NUMBER 36
Stapleton International Airport
Stage 2 Experiments: Input Data

Time period	Scheduled		General aviation			Total aircraft operations
	air carrier	commuter	turbo engine	multiengine piston	single-engine piston	
0600-1700	3	5	2	3	2	15
0700-0800	17	10	4	6	6	43
0800-0900	68	14	5	7	7	101
0900-1000	88	16	7	9	9	129
1000-1100	88	15	6	9	9	127
1100-1200	88	14	6	9	8	125
1200-1300	70	18	8	11	11	118
1300-1400	81	14	6	8	7	116
1400-1500	60	16	7	9	11	103
1500-1600	80	12	5	7	7	111
1600-1700	70	14	6	8	7	105
1700-1800	85	15	6	9	8	123
1800-1900	88	15	6	9	9	127
1900-2000	74	14	6	7	7	108
2000-2100	55	9	4	5	5	78
2100-2200	46	8	4	5	5	68
	1061	209	88	121	118	1597

Experiment Number: 37 (Input changes from experiment number 36)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	Use IFR separations
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	Increase to reflect IFR conditions.
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	All arrivals on Runway 26L, all departures on
	35L.

Experiment Number: 39 (Input changes from experiment number 36)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Increase air carrier demand by 10%.

Experiment Number: 40/41 (Input changes from experiment number 37)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Increase or reduce air carrier demand by 10%
	(based on results of Experiment No. 37.)

Experiment Number: 43 (Input changes from experiment number 36)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Reduce general aviation demand 50%.

Experiment Number: 62 (Input changes from experiment number 2)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Air carrier demand increased to 1990 level.

Experiment Number: 64 (Input changes from experiment number 10)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Reduce general aviation demand 50%.

INPUT DATA FOR EXPERIMENT NUMBER 65

Input data identical with Experiment 15 except:

1. New 5,000 foot N-S runway is implemented.
2. All class A and B aircraft arrive and depart on new runway.
3. Operations on new runway independent of operations on Runways 35L and 35R.

Attachment B

STAGE 1 EXPERIMENTS: INPUT DATA PACKAGE

STAPLETON INTERNATIONAL AIRPORT

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.

September 1978

SUMMARY OF AVERAGE DAILY DELAYS
(16-Hour Day)
(STAGE 1 EXPERIMENTS)

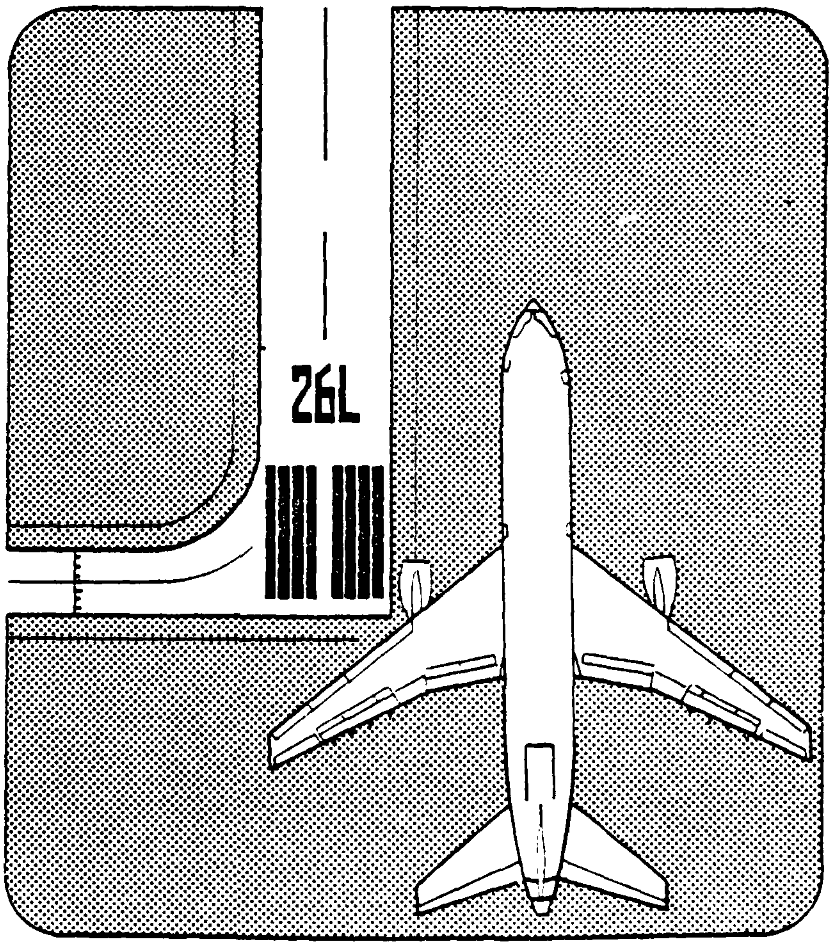
Experiment No.	Average Runway Delays to Aircraft (Minutes) Arrivals	Departures
2	1.3	2.1
4	1.7	0.9
8	2.3	1.7
9	0.7	2.0
10	*	4.0
11	*	1.9
13	0.8	1.8
15	*	*
18	2.1	1.0
29	1.4	0.5
30	1.5	0.6
31	*	*
33	2.1	1.0

*Delays in excess of one hour due to extended periods of time when demand exceeds capacity.

STAPLETON INTERNATIONAL AIRPORT

DATA PACKAGE NO. 6

AIRPORT IMPROVEMENT TASK FORCE DELAY STUDIES



prepared for
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
under contract
DOT FA77WA -3961

Peat, Marwick, Mitchell & Co.

OCTOBER 1978

PEAT, MARWICK, MITCHELL & CO.
P. O. BOX 8007
SAN FRANCISCO INTERNATIONAL AIRPORT
SAN FRANCISCO, CALIFORNIA 94128

Telephone: (415) 347-9521

November 14, 1978

Mr. Ray Fowler, AEM-100
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

Re: Data Package No. 6 for Stapleton Delay Experiments

Dear Ray:

Enclosed is data package No. 6 for Stapleton International Airport. The package contains the results of the Stage 2 delay experiments (Attachment A), a summary of delay information from the Stage 1 and Stage 2 experiments (Attachment B), and a suggested outline for the PMM&Co. airport report that documents the quantitative delay analysis performed (Attachment C). This data package should be reviewed by the Stapleton Task Force during the November 15, 1978 Task Force meeting.

Sincerely,

Steve

Stephen L. M. Hockaday
Manager

SLMH/jc
Enclosure

cc: Mr. J. R. Dupree (ALG-312)
Mr. F. Jaeger (ARM-4)

Attachment A

RESULTS OF STAGE 2 DELAY EXPERIMENTS

STAPLETON INTERNATIONAL AIRPORT

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.

November 1978

STAGE 2 EXPERIMENTS

Experiment Number	Page Number	Model	Arrival Runways	Departure Runways	Weather	Demand	ATC Scenario	Near-Term Improvements
5	2	ASM	26L,26R	35L,35R	VFR1	1978	1978	Closure of Runway 7-25
35	4	ASM	35L,35R	35L,35R	IFR2	1985	1985	Simultaneous ILS Approaches 35L, 35R
36	6	ASM	25,26L,26R	35L,35R	VRF1	1990	1990	1990 Baseline
37	8	ASM	26L	35L	IFR1	1990	1990	1990 Baseline
39	10	ASM	25,26L,26R	35L,35R	VFR1	1990	1990	Increase Air Carrier Demand by 25%
41	12	ASM	26L	35L,35R	IFR1	1990	1990	Reduce Air Carrier Demand by 10%
43*	14	ASM	25,26L,26R	35L,35R	VFR1	1990	1990	Reliever Airports-Reduce GA Demand by 50%
62	17	ASM	25,26L,26R	35L,35R	VFR1	1990	1990	1978 GA Demand
64	19	ASM	25,26L,26R	35L,35R	IFR1-VFR1	1985	1985	Reduce GA Demand by 50%
65	21	ASM	34,35R	34,35L	IFR2	1985	1985	New 5,000-ft. N-S runway
67	23	ASM	25,26L,26R	35L,35R	VFR1	1990	1990	Vortex hazard present
68	25	ASM	25,26L,26R	35L,35R	IFR1-VFR1	1985	1985	IFR 0600-1200 hours
69	27	ASM	8L,17L,17R	7,8R	IFR1-VFR1	1985	1985	Extend 26R East to equal 26L length
70	29	ASM	8L,17L,17R	7,8R	IVR1-VFR1	1985	1985	IFR 0600-1200 hours
71	31	ASM	17L,26R	26L	IFR1	1985	1985	2 IFR1 arrival streams
72	33	ASM	25,26L,26R	35L,35R	VFR1	1985	1985	25 Arrivals dependent
51	15	ADM	n.a.	n.a.	n.a.	1985	1985	1985 Near-Term Improvements
52	15	ADM	n.a.	n.a.	n.a.	1985	1985	1978 Near-Term Improvements
53	15	ADM	n.a.	n.a.	n.a.	1985	1978	1985 Near-Term Improvements
54	15	ADM	n.a.	n.a.	n.a.	1985	1978	1978 Near-Term Improvements
55	15	ADM	n.a.	n.a.	n.a.	1990	1990	1990 Near-Term Improvements
56	15	ADM	n.a.	n.a.	n.a.	1990	1990	1978 Near-Term Improvements
57	15	ADM	n.a.	n.a.	n.a.	1990	1978	1990 Near-Term Improvements
58	15	ADM	n.a.	n.a.	n.a.	1990	1978	1978 Near-Term Improvements

*Not run--low delays for baseline case, i.e., Experiment No. 36.

Experiment No. 5

Objective:

To estimate the delay impact of the closure of Runway 7-25, in VFR 1 weather.

Arrival Runways	Departure Runways
26L, 26R	35L, 35R

Related Comparison Experiments:

Experiment 2 is the 1978 baseline for comparison.

Results:

Figure 5A shows that total aircraft flows vary from 39 to 127 aircraft per hour over the 16 hour simulation run. The peak hour is from 1200 to 1300 hours and contains 54 arrival aircraft and 73 departure aircraft.

Figure 5B shows that average delays to aircraft using the runways are as high as 9.4 minutes per aircraft. Peak hour average delays are 3.0 minutes for arrival aircraft and 4.7 minutes for departure aircraft.

Comparison of the delays between 1100 and 1200 hours (the period of maximum arrival delays) with the corresponding delays for Experiment 2 shows that arrival aircraft delays are doubled (from 4.7 minutes per aircraft to 9.4 minutes per aircraft) due to the closure of Runway 7-25.

FIGURE 5A AVERAGE RUNWAY FLOW RATES

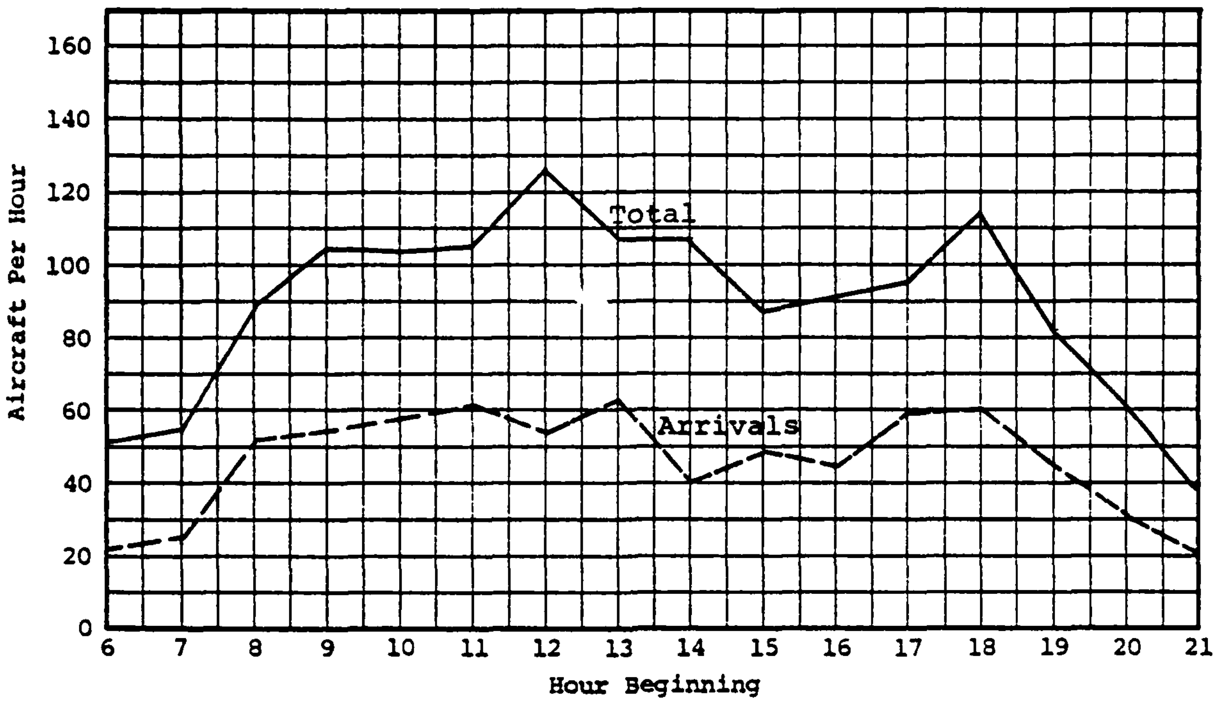
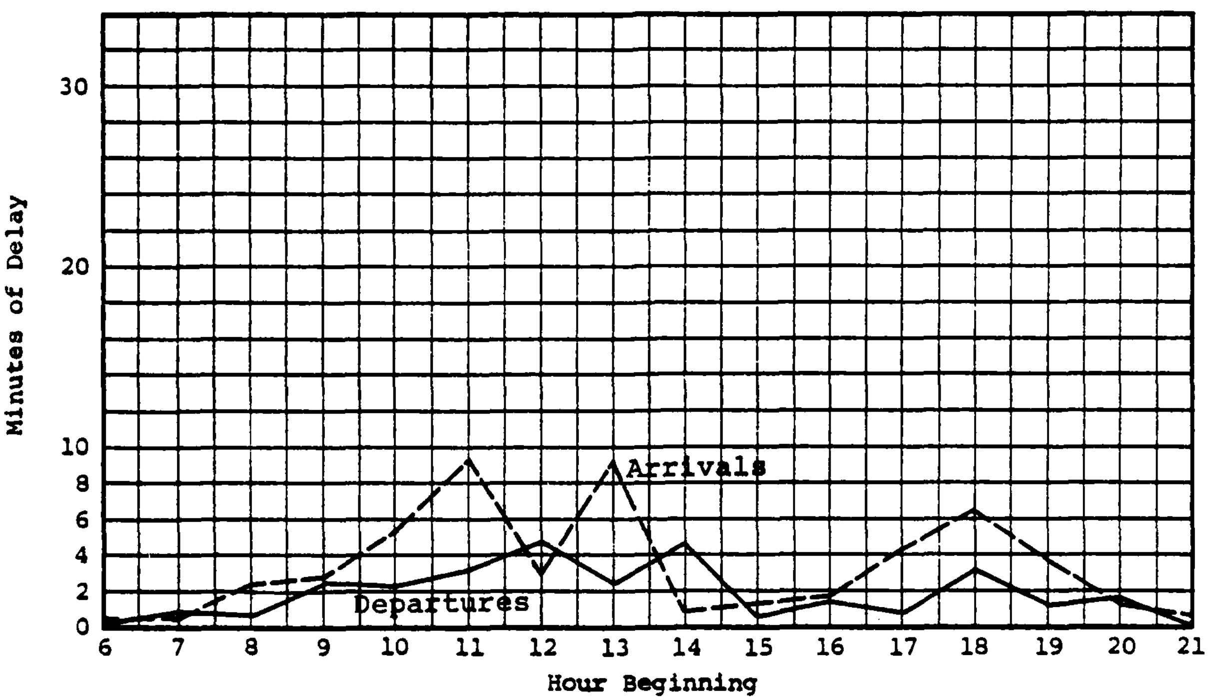


FIGURE 5B AVERAGE RUNWAY DELAYS



Experiment No. 35

Objective:

To estimate the delay impact of providing for simultaneous ILS approaches to Runways 35L and 35R in IFR 2 conditions.

Arrival Runways	Departure Runways
35L, 35R	35L, 35R

Related Comparison Experiments:

Experiment 15 is the 1985 baseline for comparison.

Results:

Figure 35A shows that total aircraft flows vary from 8 to 99 aircraft per hour over the 16 hour simulation run. The peak hour is from 1800 to 1900 hours and contains 36 arrival aircraft and 63 departure aircraft.

Figure 35B shows that average delays to aircraft using the runways are as high as 15.4 minutes per aircraft. Peak hour average delays are 0.3 minutes for arrival aircraft and 7.5 minutes for departure aircraft.

Comparison of these flows and delays with the runway flows and delays for Experiment 15 shows that providing for simultaneous ILS approaches to Runways 35L and 35R in IFR 2 conditions reduces aircraft delays significantly.

FIGURE 35A AVERAGE RUNWAY FLOW RATES

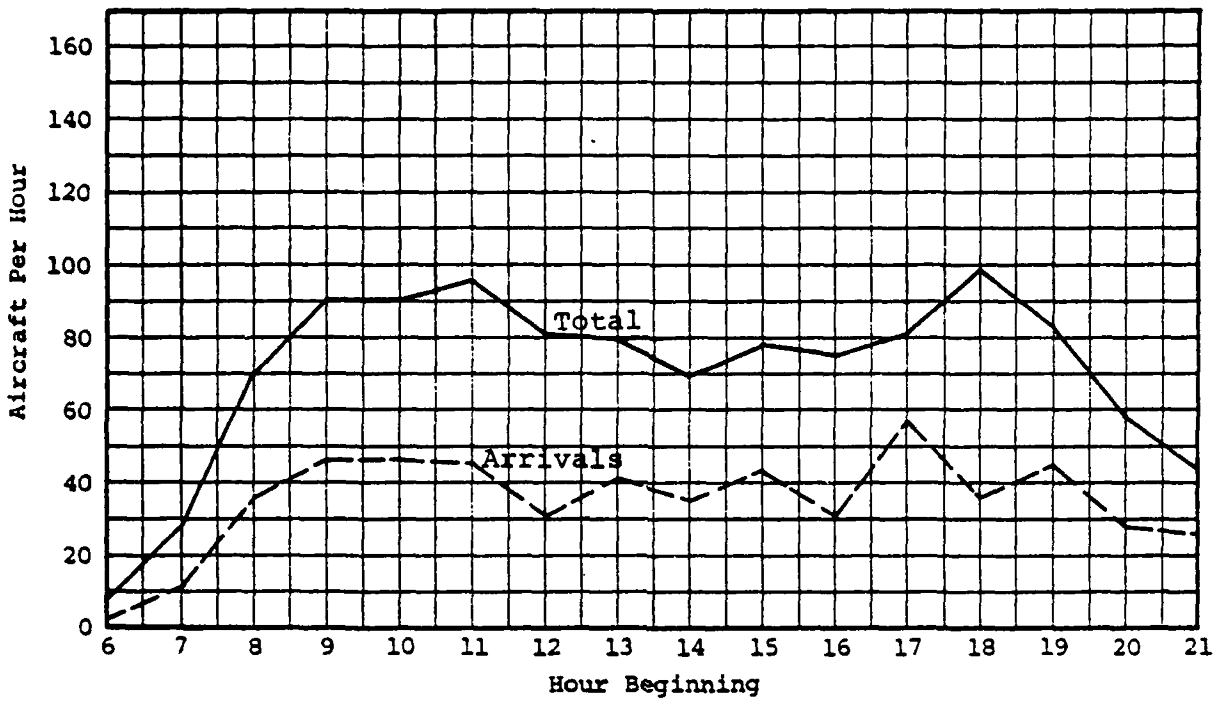
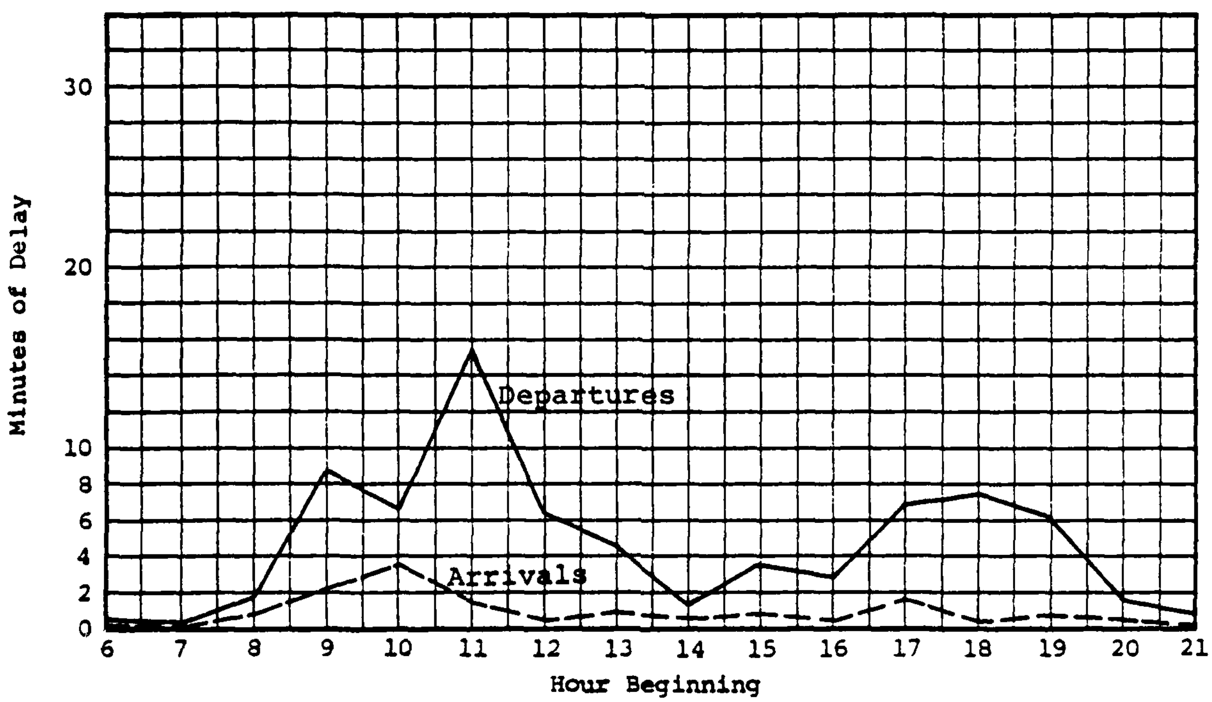


FIGURE 35B AVERAGE RUNWAY DELAYS



Experiment No. 36

Objective:

To estimate 1985 baseline delay estimates for the following runway use in VFR 1 weather:

Arrival Runways	Departure Runways
25, 26L, 26R	35L, 35R

Related Comparison Experiments:

Experiment 39 estimates the delay impact of increasing air carrier demand by 25%; Experiment 62 estimates the delay impact of operating with 1978 general aviation demand levels and Experiment 67 estimates the delay impact of having a vortex hazard present.

Results:

Figure 36A shows that total aircraft flows vary from 11 to 131 aircraft per hour over the 16 hour simulation run. The peak hour is from 1000 to 1100 hours and contains 66 arrival aircraft and 65 departure aircraft.

Figure 36B shows that average delays to aircraft using the runways are as high as 3.7 minutes per aircraft. Peak hour average delays are 0.5 minutes for arrival aircraft and 3.7 minutes for departure aircraft.

FIGURE 36A AVERAGE RUNWAY FLOW RATES

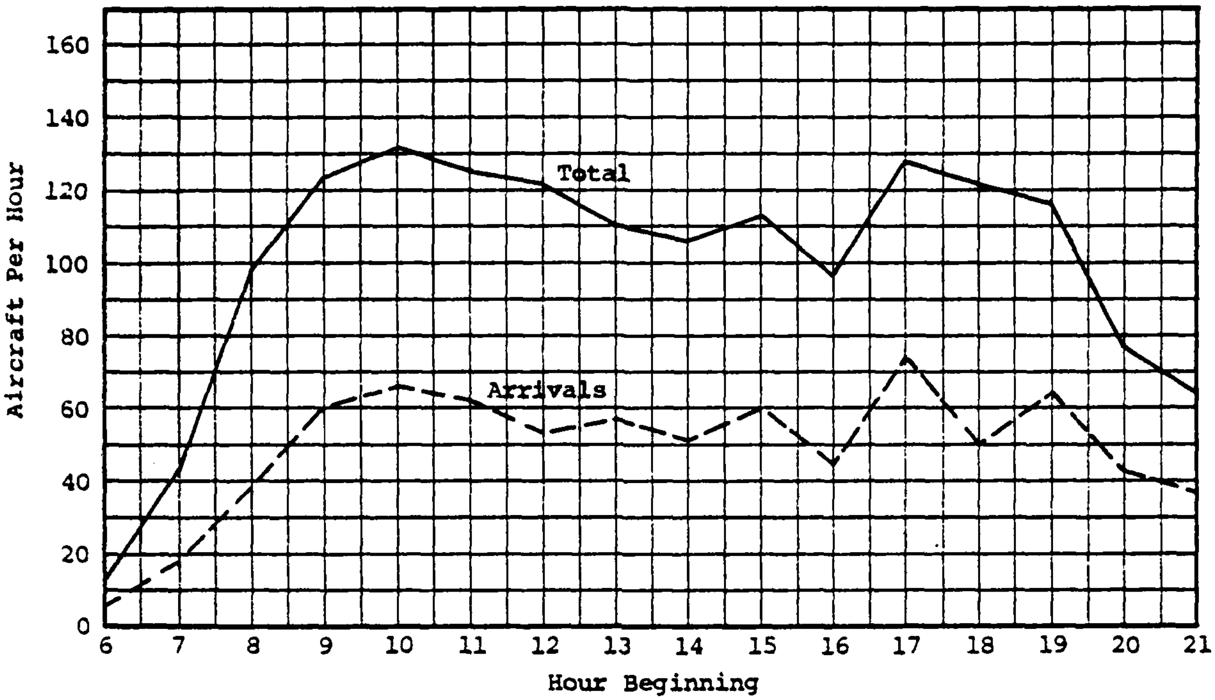
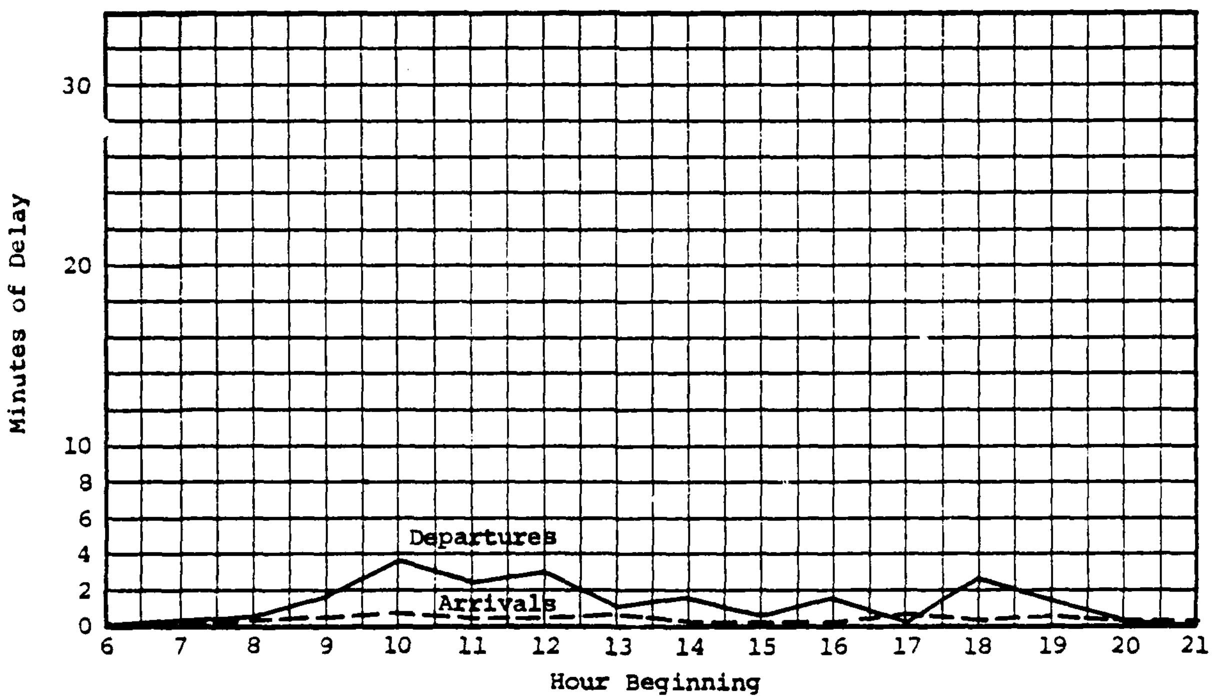


FIGURE 36B AVERAGE RUNWAY DELAYS



Experiment No. 37

Objective:

To obtain 1985 baseline delay estimates for the following runway use in IFR 1 weather:

Arrival Runways	Departure Runways
26L	35L

Related Comparison Experiments:

Experiment 41 estimates the delay impact of reducing air carrier demand to a maximum of 90 operations per hour (approximately at 10% reduction).

Results:

Figure 37A shows that total aircraft flows vary from 9 to 103 aircraft per hour over the 16 hour simulation run. The peak hour is from 0900 to 1000 hours and contains 44 arrival aircraft and 59 departure aircraft.

Figure 37B shows that departure delays range from 0 to 6.1 minutes, while arrival delays increase continually over the day to 165 minutes by the end of the 16 hours. These very high arrival delays are due to an excess of demand over capacity. In practice, IFR weather rarely occurs for 16 hours straight. In any event, delays of 165 minutes are unrealistic as cancellations and diversions would occur before delays build up to this level.

FIGURE 37A AVERAGE RUNWAY FLOW RATES

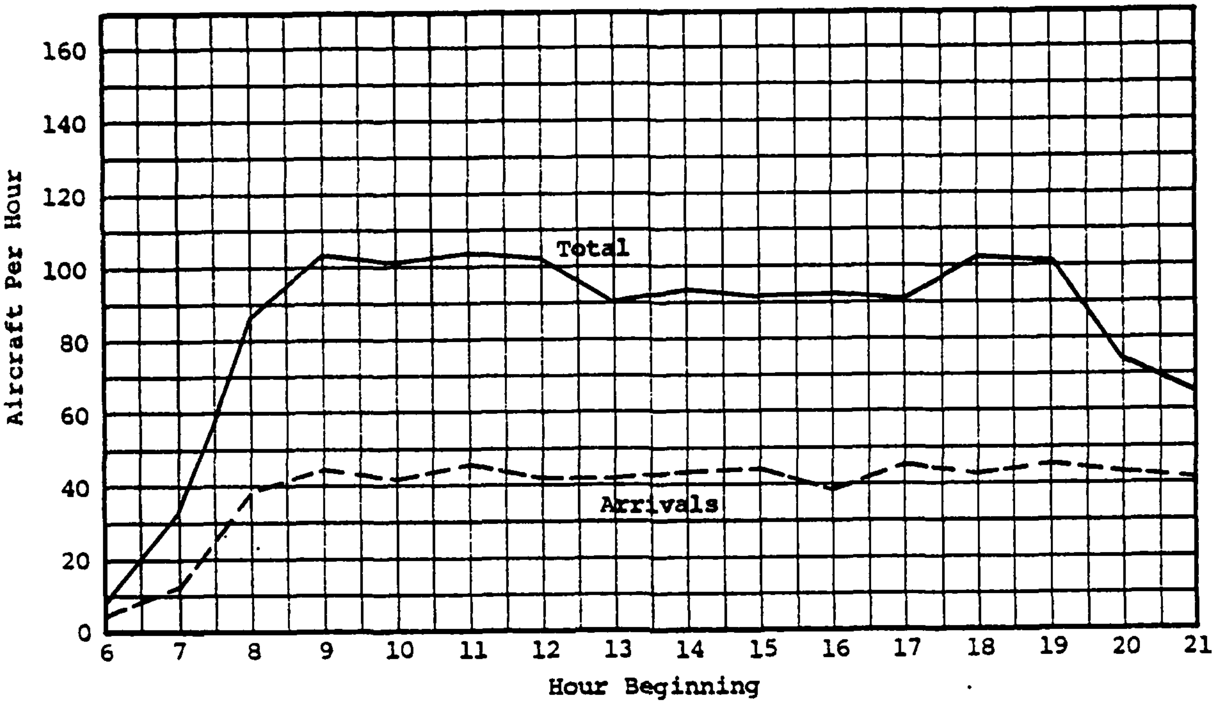
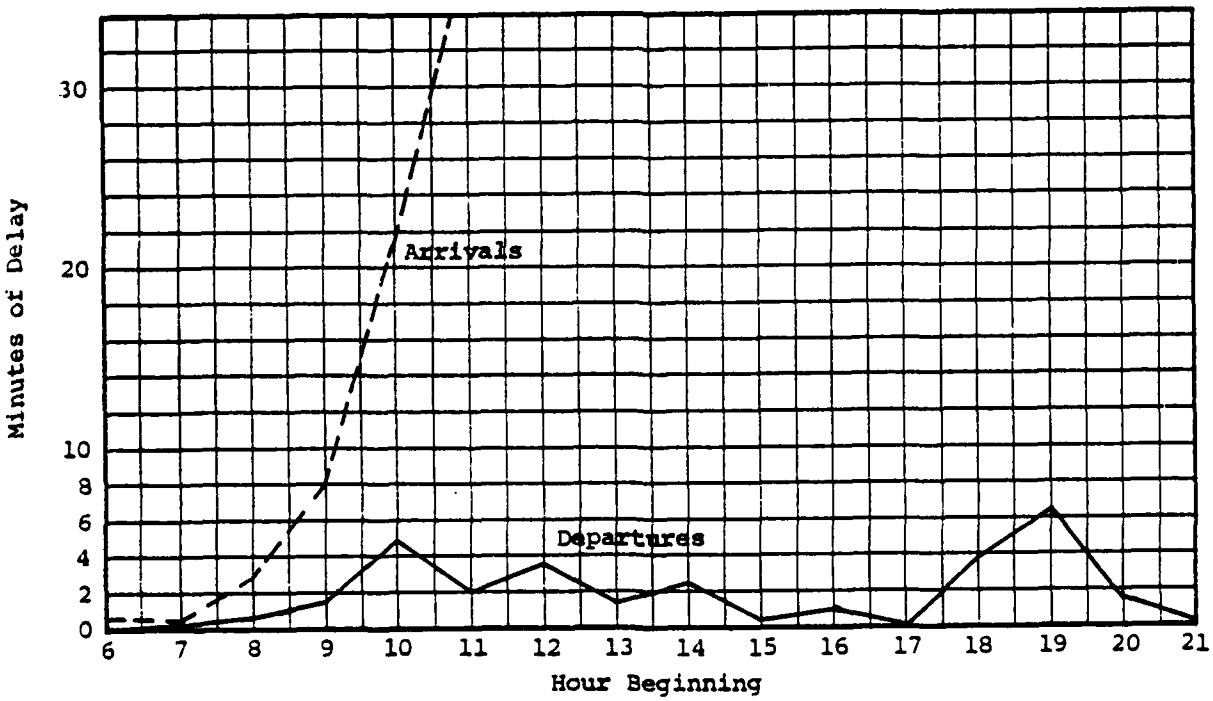


FIGURE 37B AVERAGE RUNWAY DELAYS



Experiment No. 39

Objective:

To estimate the delay impact of increasing air carrier demand by 25% in VFR 1 conditions.

Arrival Runways	Departure Runways
25, 26L, 26R	35L, 35R

Related Comparison Experiments:

Experiment 36 is the 1990 baseline for comparison.

Results:

Figure 39A shows that total aircraft flows vary from 11 to 152 aircraft per hour over the 16 hour simulation run. The peak hour is from 1000 to 1100 hours and contains 75 arrival aircraft and 77 departure aircraft.

Figure 39B shows that average delays to aircraft using the runways are as high as 4.1 minutes per aircraft. Peak hour average delays are 1.3 minutes for arrival aircraft and 4.1 minutes for departure aircraft.

Comparison of these flows and delays with the runway flows and delays for Experiment 36 shows that both arrival and departure delays are increased, although not significantly, when air carrier demand is increased by 25% in VFR1 conditions.

FIGURE 39A AVERAGE RUNWAY FLOW RATES

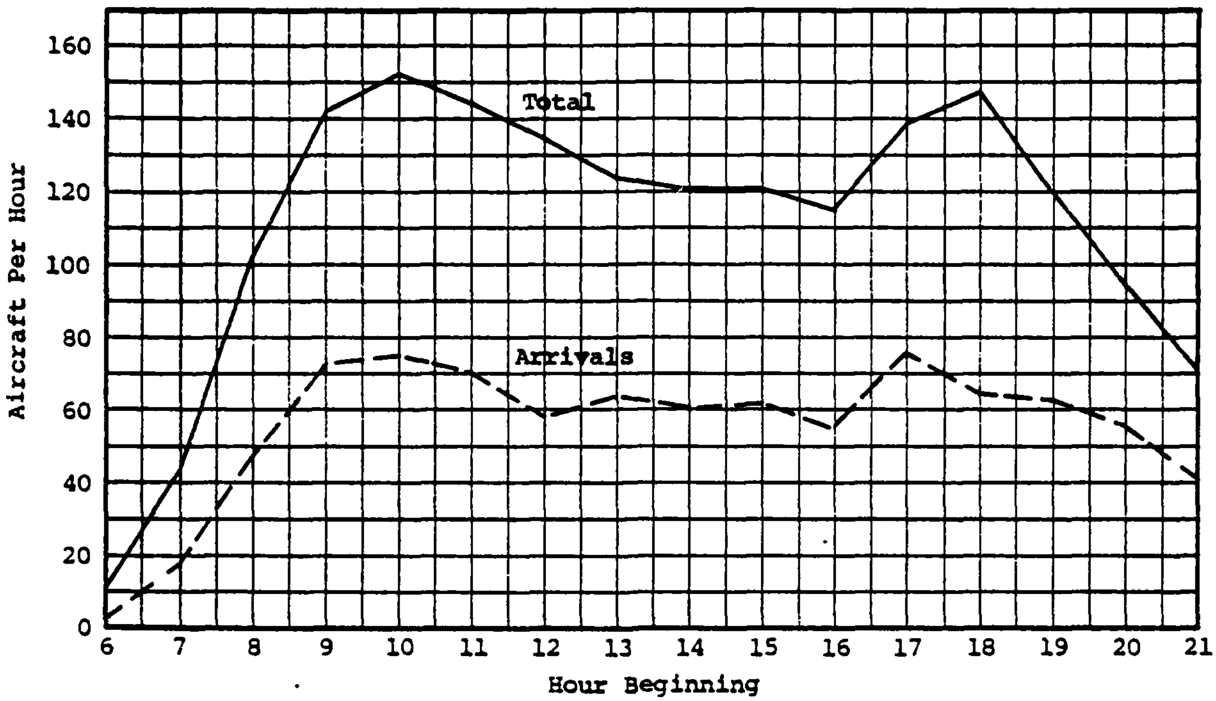
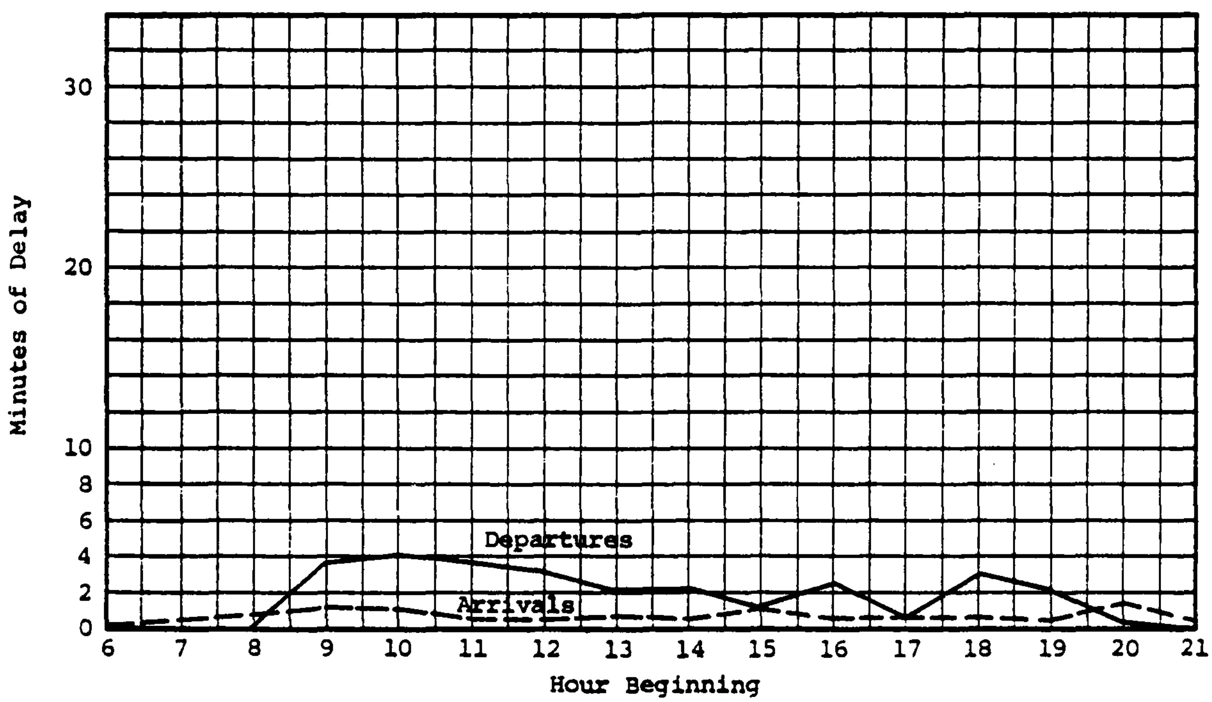


FIGURE 39B AVERAGE RUNWAY DELAYS



Experiment No. 41

Objective:

To estimate the delay impact of reducing air carrier demand by 10% in IFR 1 conditions.

Arrival Runways	Departure Runways
26L	35L, 35R

Related Comparison Experiments:

Experiment 37 is the 1990 baseline for comparison.

Results:

Figure 41A shows that total aircraft flows vary from 11 to 96 aircraft per hour over the 16 hour simulation run. The peak hour is from 1800 to 1900 hours and contains some 42 arrival aircraft and 54 departure aircraft.

Figure 41B shows that average delays to aircraft using the runways are as high as some 30 minutes per aircraft. Peak hour average delays are some 28 minutes for arrival aircraft. There is virtually no delay to departure aircraft.

Comparison of these flows and delays with the runway flows and delays for Experiment 37 shows that by reducing air carrier demand by 10% in IFR 1 conditions arrival aircraft delays are reduced to the extent that the Airport could continue to operate for some 16 hours in IFR 1 weather without significant cancellations or diversions.

FIGURE 41A AVERAGE RUNWAY FLOW RATES

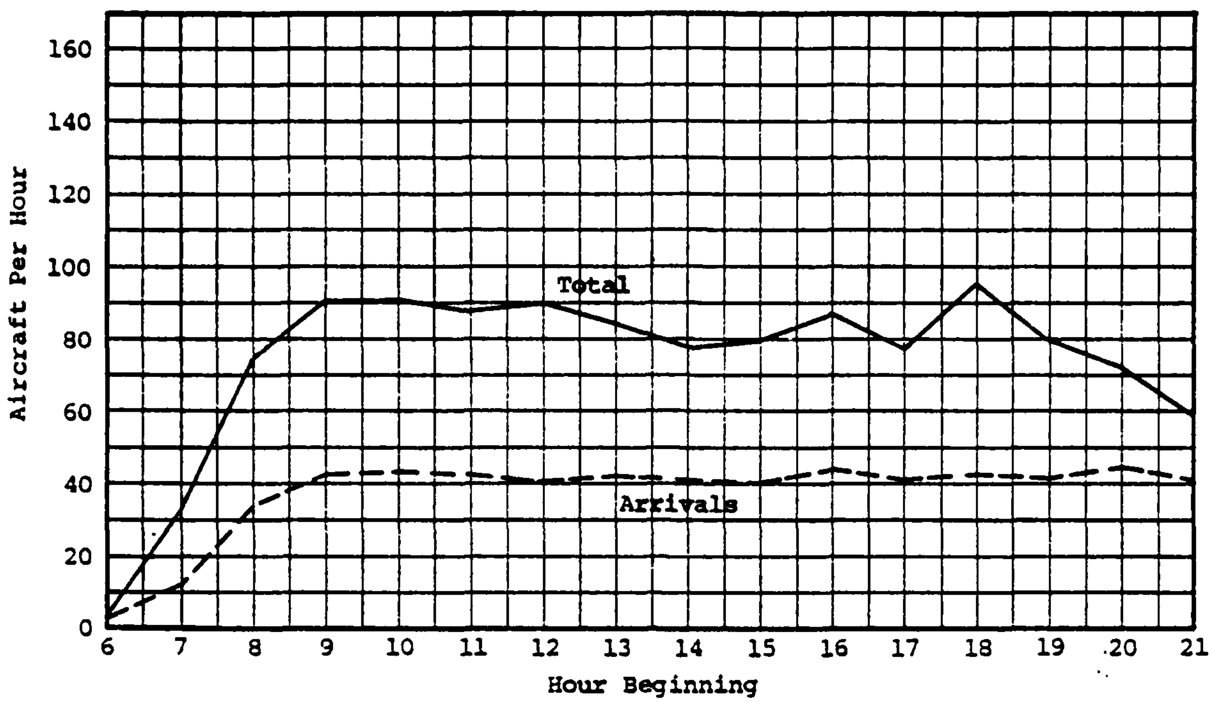
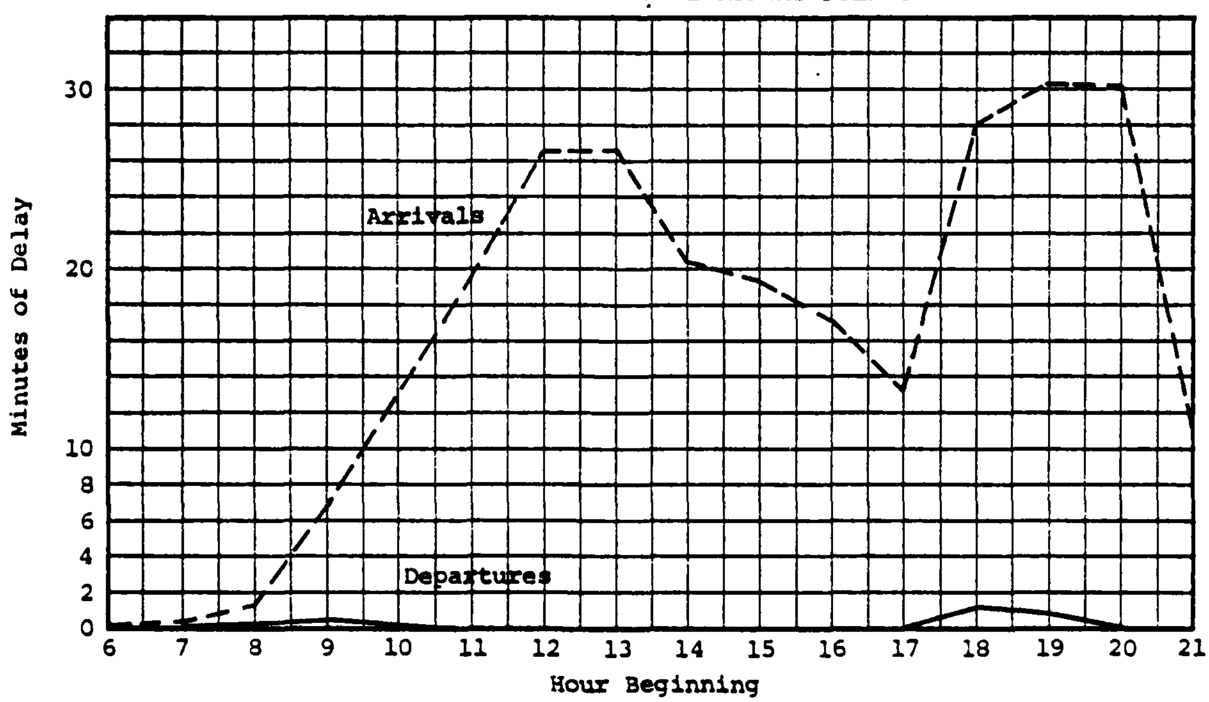


FIGURE 41B AVERAGE RUNWAY DELAYS



Experiment No. 43

Objective:

To estimate the delay impact of a reliever Airport, i.e., reduce general aviation demand by 50% in VFR 1 conditions.

Arrival Runways	Departure Runways
25, 26L, 26R	35L, 35R

Related Comparison Experiments:

Experiment 36 is the 1990 baseline for comparison.

Results:

This experiment was not performed due to the low levels of aircraft delay observed from the baseline experiment.

Experiment Nos. 51-58

Objective:

To determine average annual delays to aircraft in 1978, 1985 and 1990 under varying demand ATC scenarios and near-term improvements.

Results:

With a 1978 demand level of 512,500 annual operations, average annual delays were estimated to be 1.6 minutes per aircraft. Under the "do-nothing" scenario (i.e., 1978 ATC scenario and near-term improvements) average annual delays are estimated to increase to some 2.0 minutes per aircraft in 1985 and to some 4.8 minutes per aircraft in 1990.

Based on the most optimistic scenario (i.e., ATC scenarios and near-term improvements being implemented in a timely fashion), average annual delays are estimated to be some 1.6 minutes per aircraft in 1985 and to be some 0.4 minutes per aircraft in 1990. Table 1, which summarizes the results for each of the annual delay experiments, shows total annual delays, average aircraft delays (on an annual basis), summarizes the distribution of the average aircraft delays (percent of all delays less than 1 minute, 5 minutes and 10 minutes) and shows the average peak hour delays for the most frequent runway use, i.e., arrivals on Runways 25, 26L and 26R, departures on Runways 35L and 35R under VFR 1, VFR 2, IFR 1 and IFR 2 weather conditions.

Table 1

SUMMARY OF ANNUAL DELAY EXPERIMENTS RESULTS

Expt. No.	Demand[a]	ATC Scenario	NTI	Annual Delay (hours)	Average Aircraft Delay (minutes)	Percent of delays[b] less than: 1 min.	5 mins.	10 mins.	Average peak hour delays for arrivals 25, 26L, 26R; departures 35L, 35R: VFR1	VFR2	IFR
50	1978	1978	1978	13,946	1.6	83%	97%	98%	1.1	2.3	65.6
51	1985	1985	1985	14,015	1.6	86	97	98	0.9	2.8	61.9
52	1985	1985	1978	14,404	1.7	86	96	97	0.9	2.8	61.9
53	1985	1978	1985	17,270	2.0	81	96	99	1.2	3.6	65.7
54	1985	1978	1978	17,696	2.0	81	96	99	1.2	3.6	65.7
55	1990	1990	1990	3,761	0.4	98	99	99	0.5	2.7	1.9
56	1990	1990	1978	11,944	1.2	90	95	96	0.9	2.7	7.3
57	1990	1978	1990	7,923	0.8	92	98	99	1.1	7.7	52.3
58	1990	1978	1978	46,343	4.8	57	90	92	1.9	44.8	74.6

a. Annual demand 1978 = 512,500
1985 = 524,270
1990 = 575,650

b. On an annual basis.

Experiment No. 62

Objective:

To estimate the delay impact of operating at 1990 air carrier and 1978 general aviation demand levels in VFR 1 conditions.

Arrival Runways	Departure Runways
25, 26L, 26R	35L, 35R

Related Comparison Experiments:

Experiment 36 is the 1990 baseline for comparison.

Results:

Figure 62A shows that total aircraft flows vary from 35 to 140 aircraft per hour over the 16 hour simulation run. The peak hour is from 0900 to 1000 hours and contains 71 arrival aircraft and 6 departure aircraft.

Figure 62B shows that average delays to aircraft using the runways are as high as 3.7 minutes per aircraft. Peak hour average delays are 1.0 minutes for arrival aircraft and 3.7 minutes for departure aircraft.

Comparison of these flows and delays with the runway flows and delays for Experiment 36 shows that while aircraft delays increase somewhat at these demand levels, the increase is virtually insignificant.

FIGURE 62A AVERAGE RUNWAY FLOW RATES

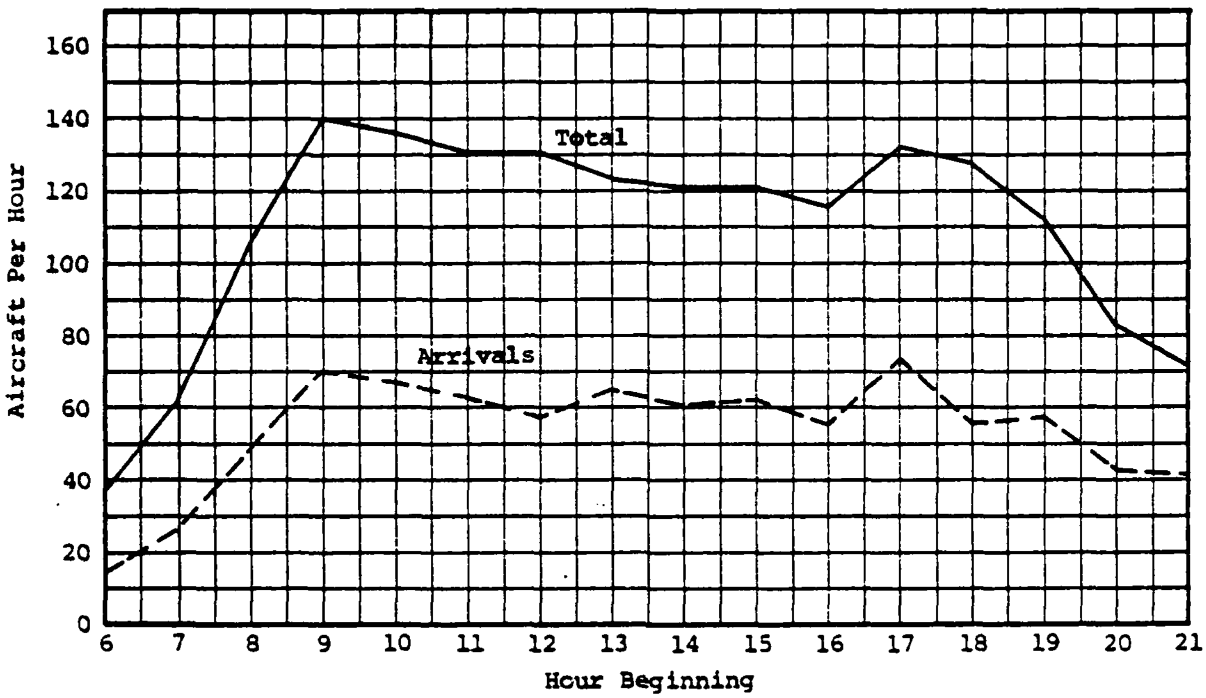
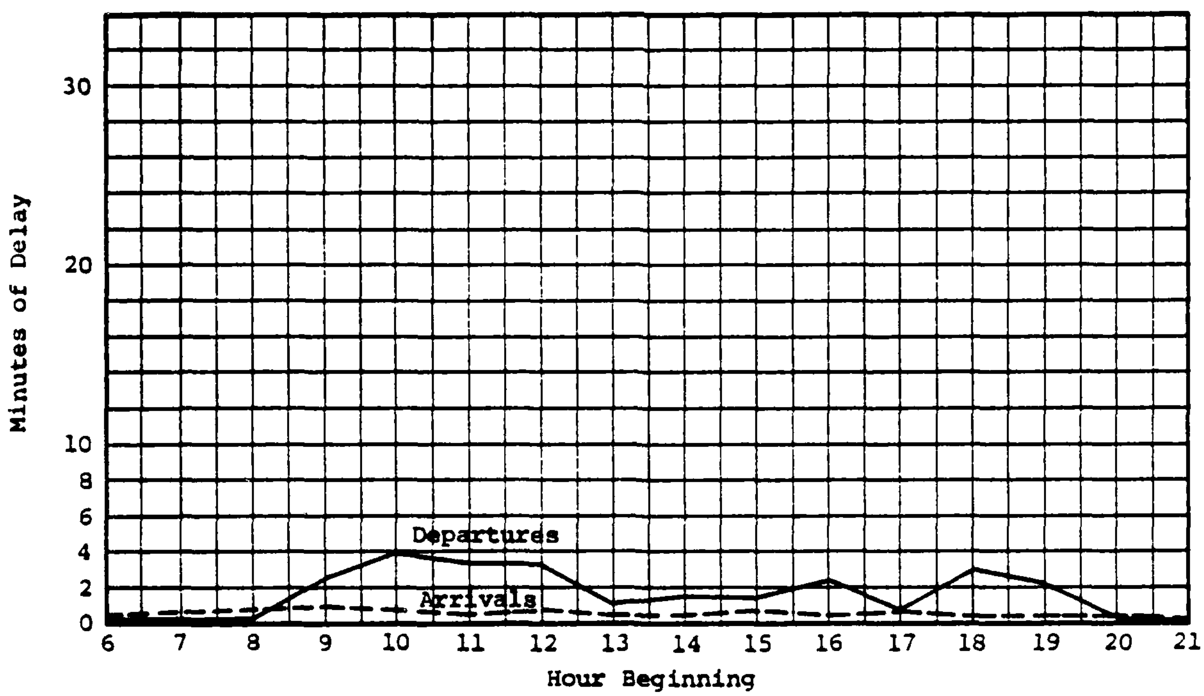


FIGURE 62B AVERAGE RUNWAY DELAYS



Experiment No. 64

Objective:

To estimate the delay impact of reducing general aviation demand by 50% when the first six hours of the run (0600 to 1200) are under IFR 1 conditions.

	Arrival Runways	Departure Runways
IFR 1:	26L	35L
VFR 1:	25, 26, 26R	35, 35R

Related Comparison Experiments:

Experiment 68 is the 1985 baseline for comparison.

Results:

Figure 64A shows that total aircraft flows vary from 11 to 111 aircraft per hour over the 16 hour simulation run. The peak hour is from 1200 to 1300 hours and contains 59 arrival aircraft and 52 departure aircraft.

Figure 64B shows that average delays to aircraft using the runways are as high as 48 minutes per aircraft. Peak hour average delays are 45 minutes for arrival aircraft and 2.5 minutes for departure aircraft.

Comparison of these flows and delays with the runway flows and delays for Experiment 68 shows that both arrival and departure delays are reduced significantly with a 50% reduction in general aviation demand (for this combination of weather conditions). Arrival delays are dramatically reduced (by as much as 30 minutes in some hours).

FIGURE 64A AVERAGE RUNWAY FLOW RATES

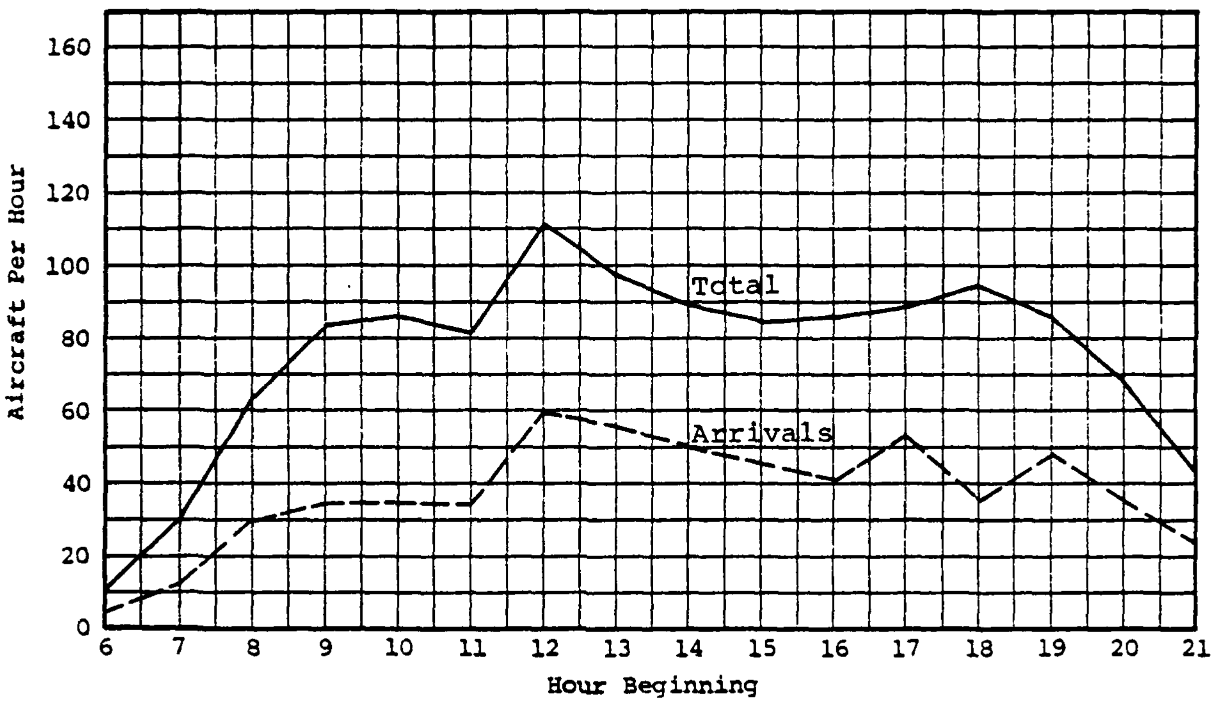
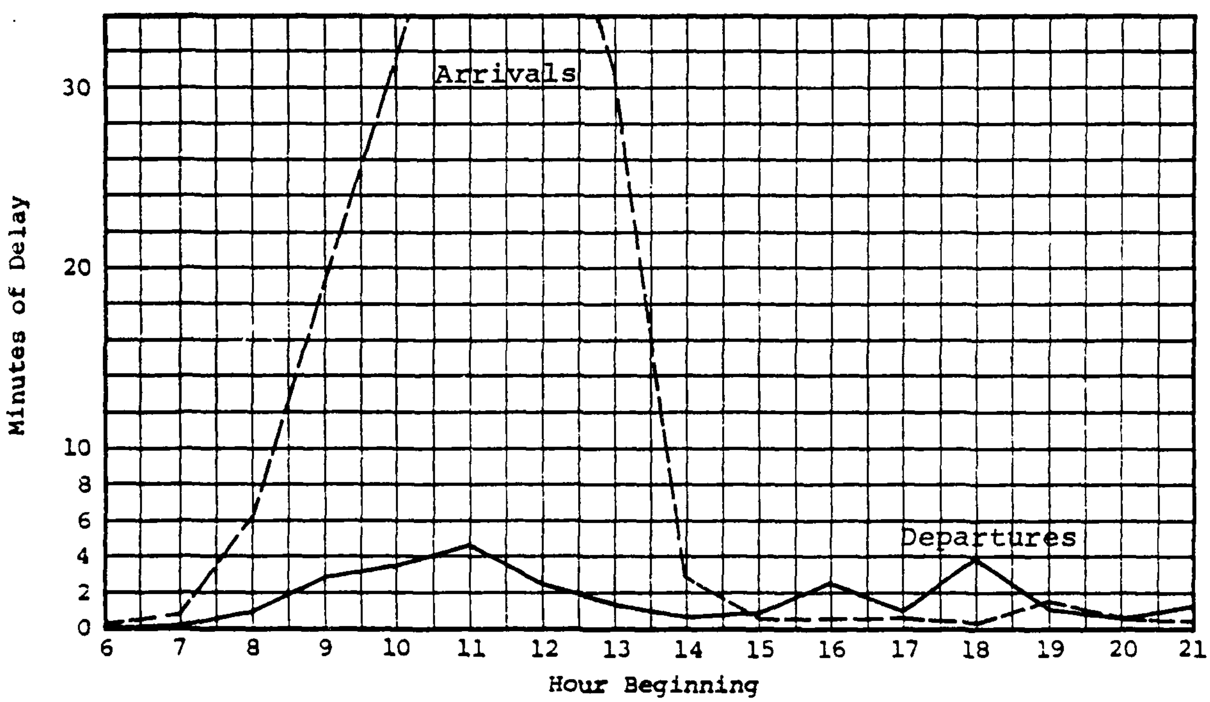


FIGURE 64B AVERAGE RUNWAY DELAYS



Experiment No. 65

Objective:

To estimate the delay impact of a new 5,000-foot N-S runway (Runway 34) in IFR 2 conditions.

Arrival Runways	Departure Runways
34, 35R	34, 35L

Related Comparison Experiments:

Experiment 15 is the 1985 baseline for comparison.

Results:

Figure 65A shows that total aircraft flows vary from 8 to 95 aircraft per hour over the 16 hour simulation run. The peak hour is from 1800 to 1900 hours and contains 43 arrival aircraft and 52 departure aircraft.

Figure 65B shows that average delays to aircraft using the runways are as high as some 21 minutes per aircraft. Peak hour average delays are some 21 minutes for arrival aircraft and 3.9 minutes for departure aircraft.

Comparison of these flows and delays with the runway flows and delays for Experiment 15 shows that a new 5,000-foot N-S runway will significantly reduce aircraft delays in IFR 2 conditions.

FIGURE 65A AVERAGE RUNWAY FLOW RATES

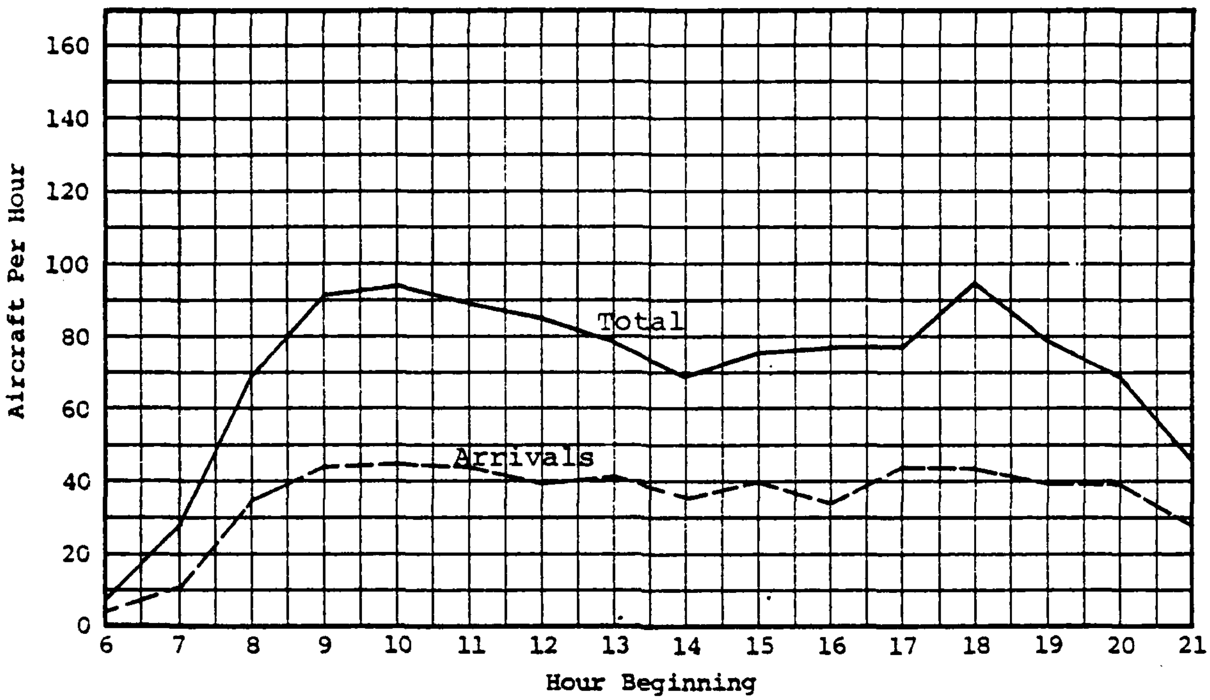
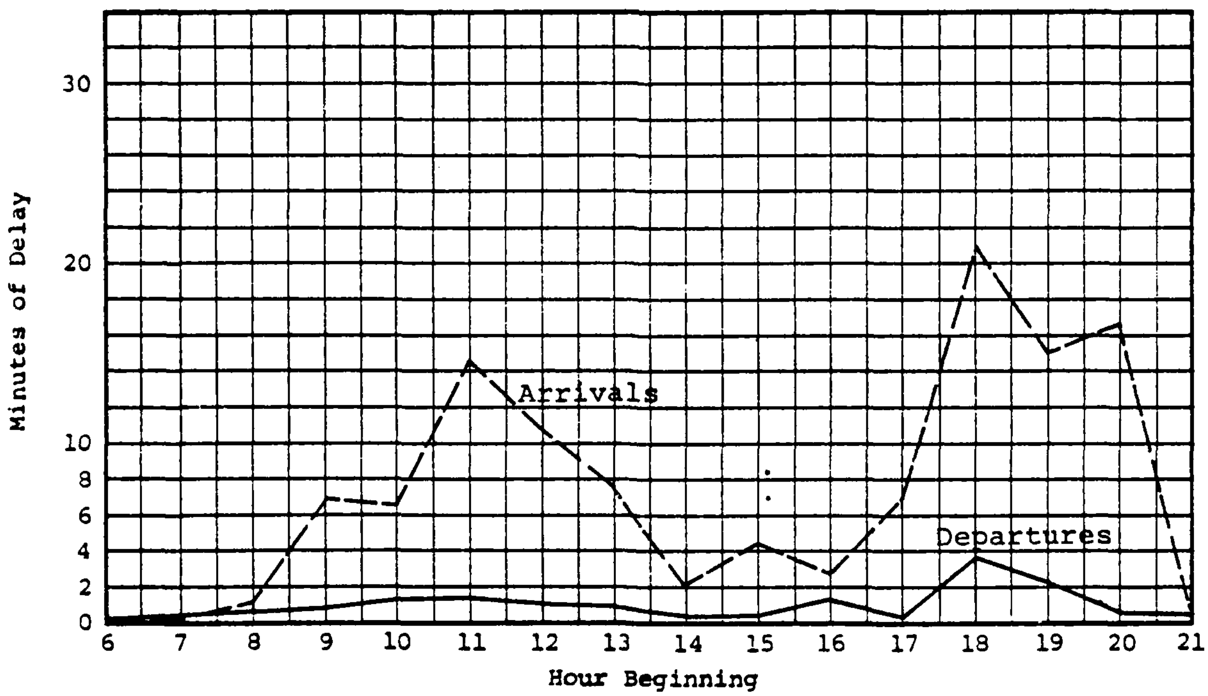


FIGURE 65B AVERAGE RUNWAY DELAYS



Experiment No. 67

Objective:

To estimate the delay impact of the presence of vortex hazards in VFR 1 conditions.

Arrival Runways	Departure Runways
25, 26L, 26R	35L, 35R

Related Comparison Experiments:

Experiment 36 is the 1990 baseline for comparison.

Results:

Figure 67A shows that total aircraft flows vary from 11 to 135 aircraft per hour over the 16 hour simulation run. The peak hour is from 1000 to 1100 hours and contains 66 arrival aircraft and 69 departure aircraft.

Figure 67B shows that average delays to aircraft using the runways are as high as 5.0 minutes per aircraft. Peak hour average delays are 0.9 minutes for arrival aircraft and 5.0 minutes for departure aircraft.

Comparison of these flows and delays with the runway flows and delays for Experiment 36 shows that the presence of vortex hazards increases departure runway delays significantly.

FIGURE 67A AVERAGE RUNWAY FLOW RATES

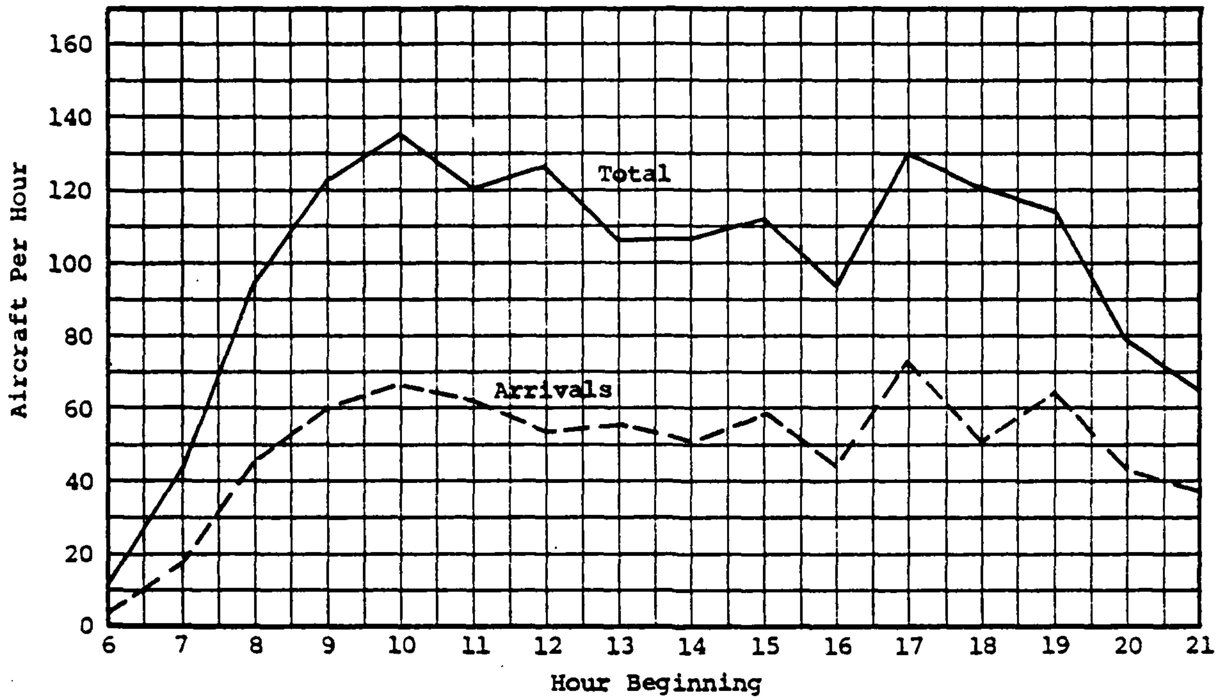
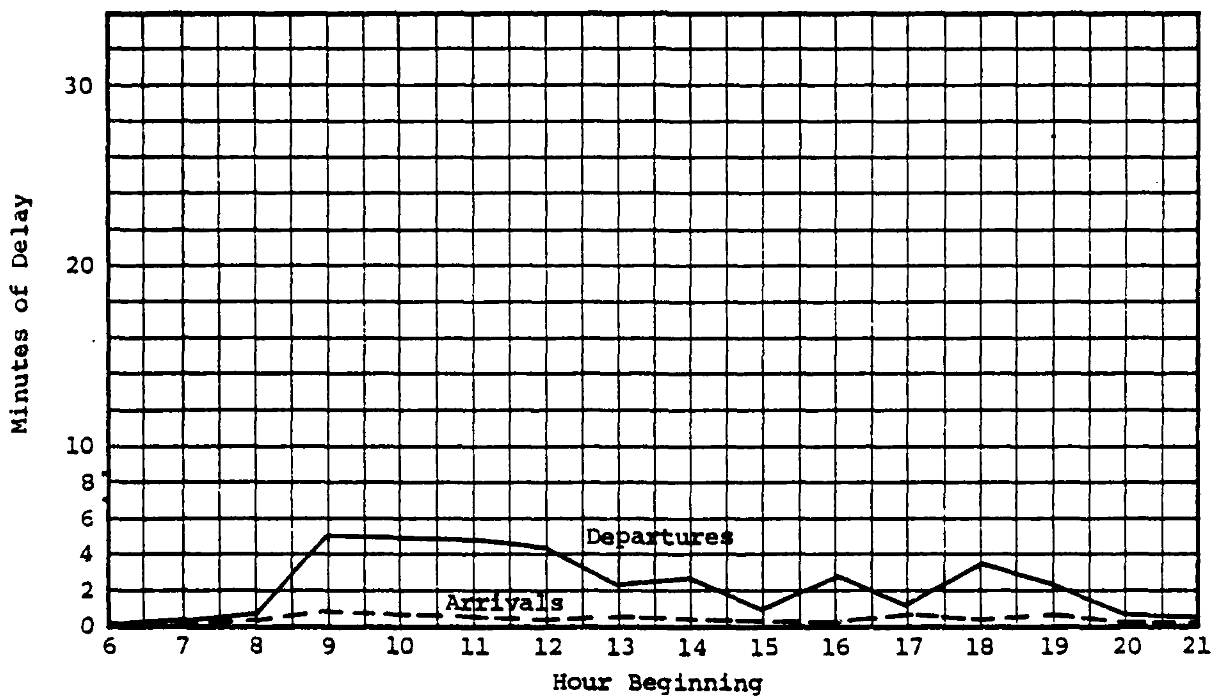


FIGURE 67B AVERAGE RUNWAY DELAYS



Experiment No. 68

Objective:

To obtain 1985 baseline delay estimates for the following runway use when weather conditions are IFR 1 for the period 0600 to 1200 hours and VFR 1 for the period 1200 to 2200 hours.

	Arrival Runways	Departure Runways
IFR 1:	26L	35L
VFR 1:	25, 26L, 26R	35L, 35R

Related Comparison Experiments:

Experiment 64 estimates the delay impact of reducing general aviation demand by 50%.

Results:

Figure 68A shows that total aircraft flows vary from 17 to 125 aircraft per hour over the 16 hour simulation run. The peak hour is from 1200 to 1300 hours and contains 63 arrival aircraft and 62 departure aircraft.

Figure 68B shows that average delays to aircraft using the runways are as high as some 63 minutes per aircraft. Peak hour average delays are some 54 minutes for arrival aircraft and 3.5 minutes for departure aircraft.

FIGURE 68A AVERAGE RUNWAY FLOW RATES

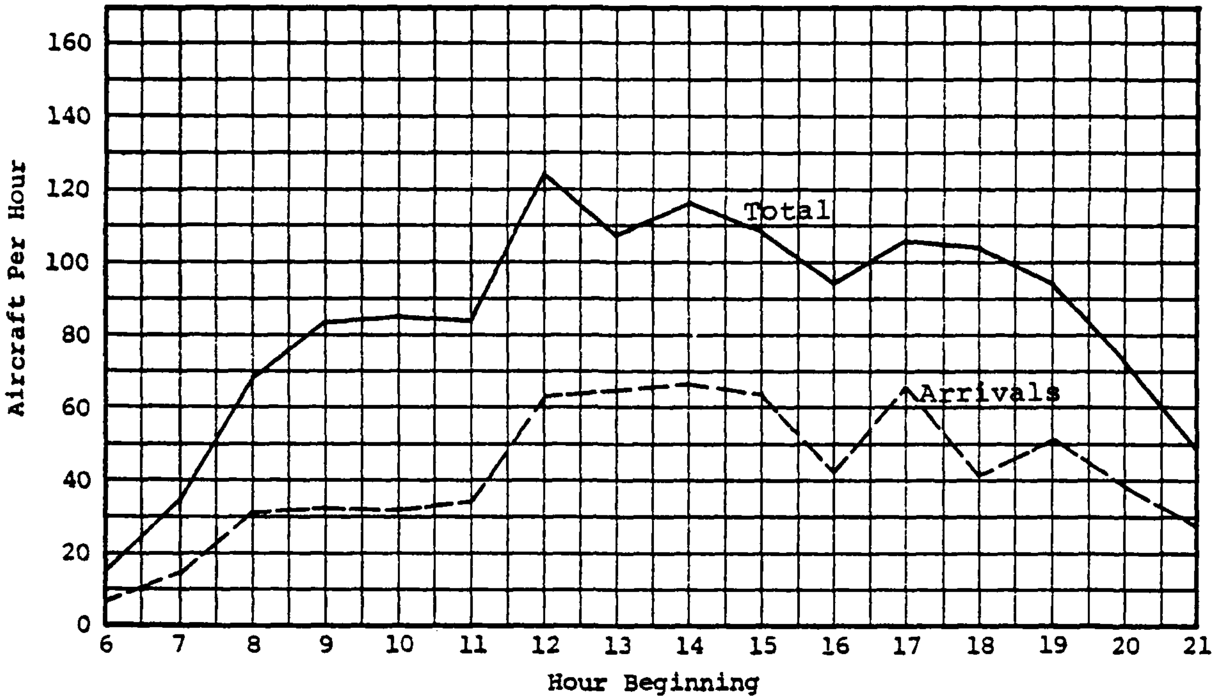
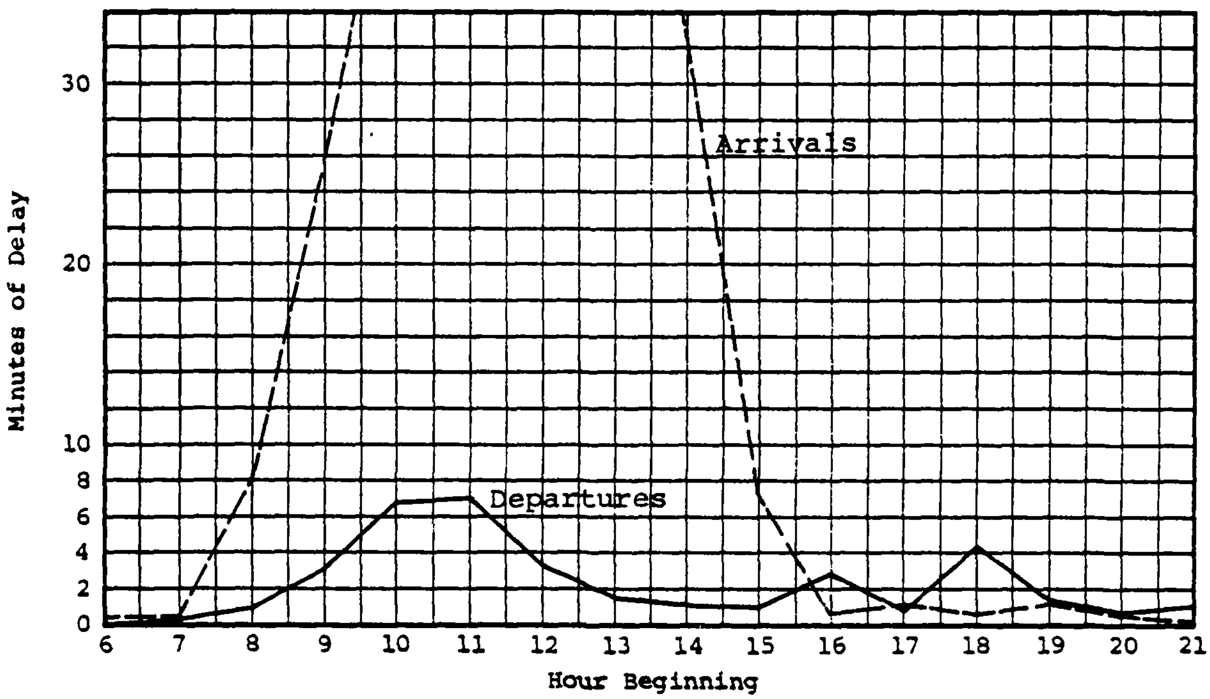


FIGURE 68B AVERAGE RUNWAY DELAYS



Experiment No. 69

Objective:

To estimate the delay impact of extending Runway 26R east to equal the length of Runway 26L.

	Arrival Runways	Departure Runways
IFR 1:	8L, 17L	8R
VFR 1:	8L, 17L, 17R	7, 8R

Related Comparison Experiments:

Experiment 70 is the 1985 baseline for comparison.

Results:

Figure 69A shows that total aircraft flows vary from 18 to 110 aircraft per hour over the 16 hour simulation run. The peak hour is from 1200 to 1300 hours and contains 52 arrival aircraft and 58 departure aircraft.

Figure 69B shows that average delays to aircraft using the runways are as high as 13 minutes per aircraft. Peak hour average delays are 3.8 minutes for arrival aircraft and 0.8 minutes for departure aircraft.

Comparison of these flows and delays with the runway flows and delays for Experiment 70 shows that extending Runway 26R reduces departure delays by as much as 2 minutes per aircraft in some periods of the day.

FIGURE 69A AVERAGE RUNWAY FLOW RATES

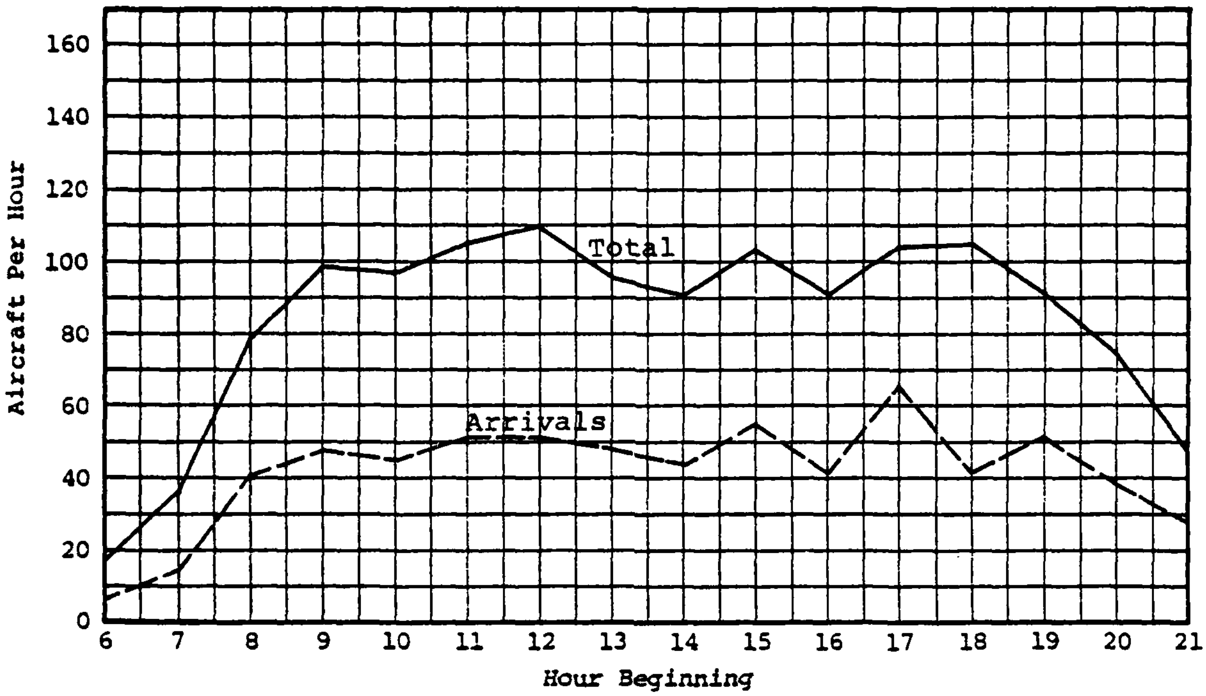
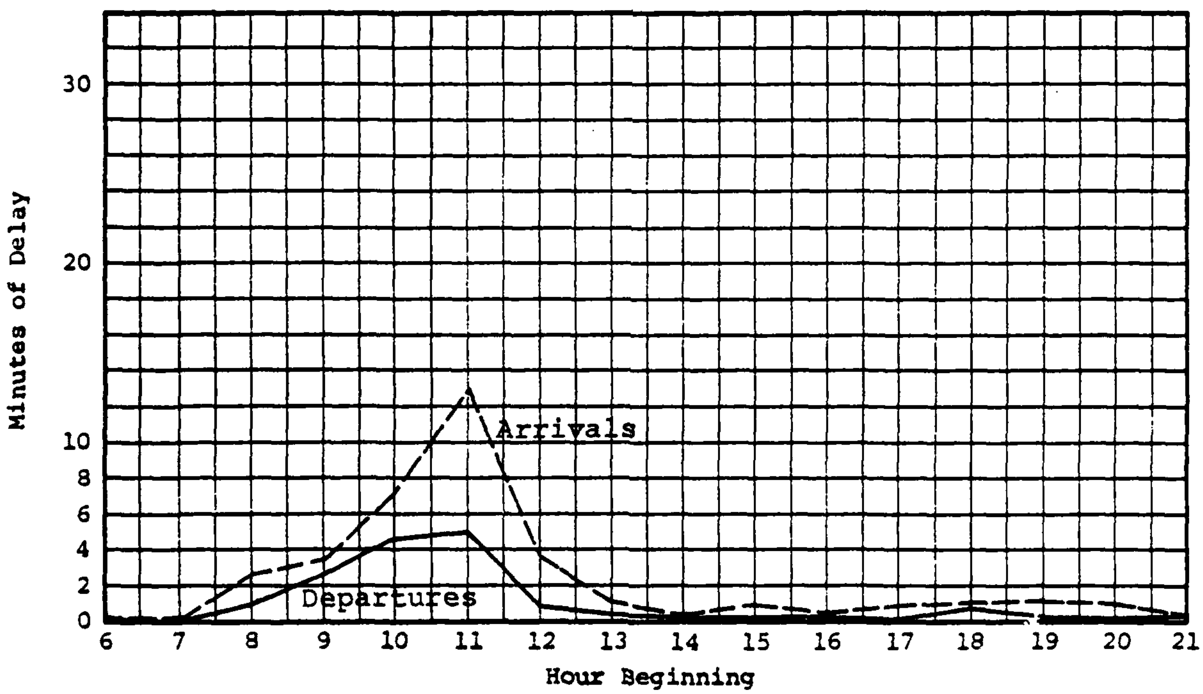


FIGURE 69B AVERAGE RUNWAY DELAYS



Experiment No. 70

Objective:

To obtain 1985 baseline delay estimates for the following runway use when weather conditions are IFR 1 for the period 0600 to 1200 hours and VFR 1 for the period 1200 to 2200 hours.

	Arrival Runways	Departure Runways
IFR 1:	8L, 17L	8R
VFR 1:	8L, 17L, 17R	7, 8R

Related Comparison Experiments:

Experiment 69 estimates the delay impact of extending Runway 26R east to equal the length of Runway 26L.

Results:

Figure 70A shows that total aircraft flows vary from 18 to 112 aircraft per hour over the 16 hour simulation run. The peak hour is from 1200 to 1300 hours and contains 52 arrival aircraft and 60 departure aircraft.

Figure 70B shows that average delays to aircraft using the runways are as high as 12 minutes per aircraft. Peak hour average delays are 3.1 minutes for arrival aircraft and 1.8 minutes for departure aircraft.

FIGURE 70A AVERAGE RUNWAY FLOW RATES

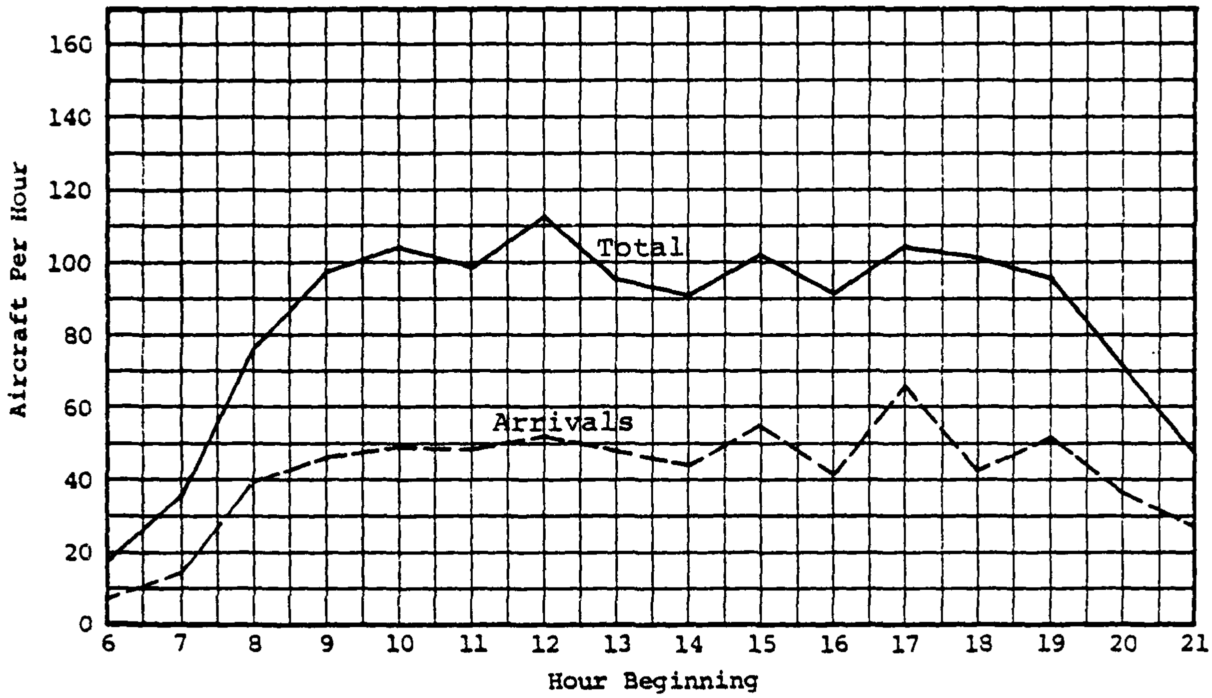
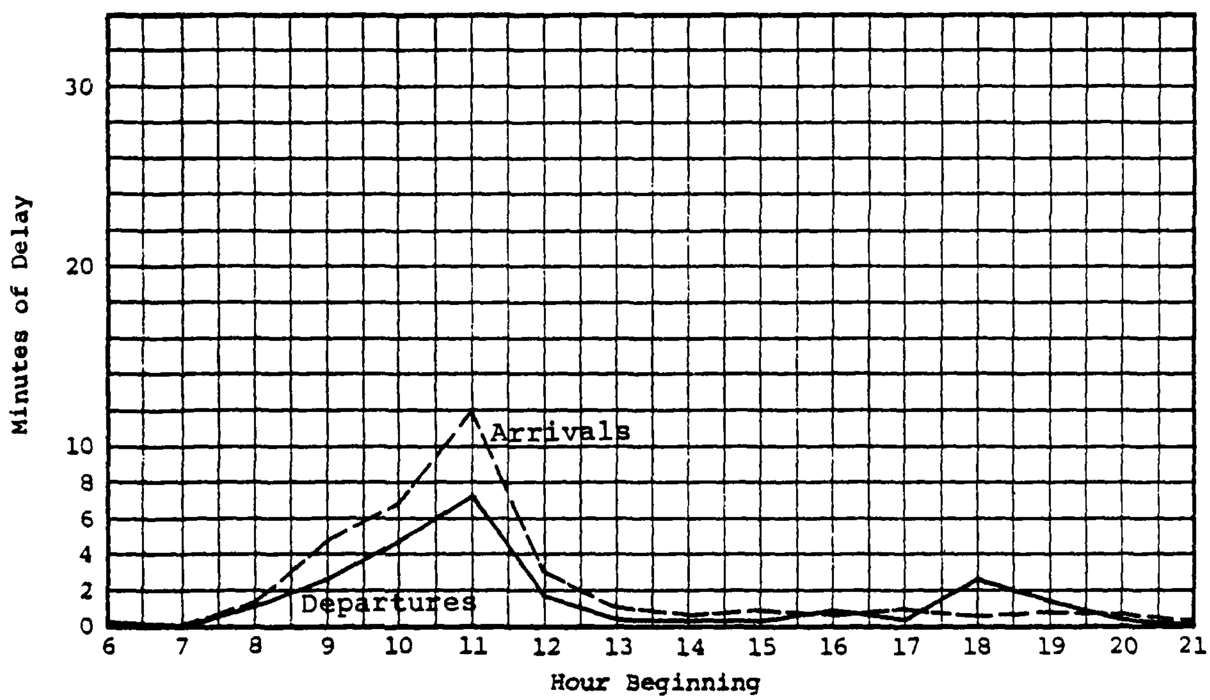


FIGURE 70B AVERAGE RUNWAY DELAYS



Experiment No. 71

Objective:

To estimate the delay impact of two independent IFR 1 arrival streams.

Arrival Runways	Departure Runways
17L, 26R	26L

Related Comparison Experiments:

Experiment 10 may be used as a baseline for comparison of arrival delays.

Results:

Figure 71A shows that total aircraft flows vary from 19 to 105 aircraft per hour over the 16 hour simulation run. The peak hour is from 1000 to 1100 hours and contains 52 arrival aircraft and 53 departure aircraft.

Figure 71B shows that average delays to aircraft using the runways are as high as 9.3 minutes per aircraft. Peak hour average delays are 4.2 minutes for arrival aircraft and 7.2 minutes for departure aircraft.

Comparison of these flows and delays with the runway flows and delays for Experiment 10 shows that with two independent arrival streams in IFR 1 conditions arrival delays are reduced significantly.

FIGURE 71A AVERAGE RUNWAY FLOW RATES

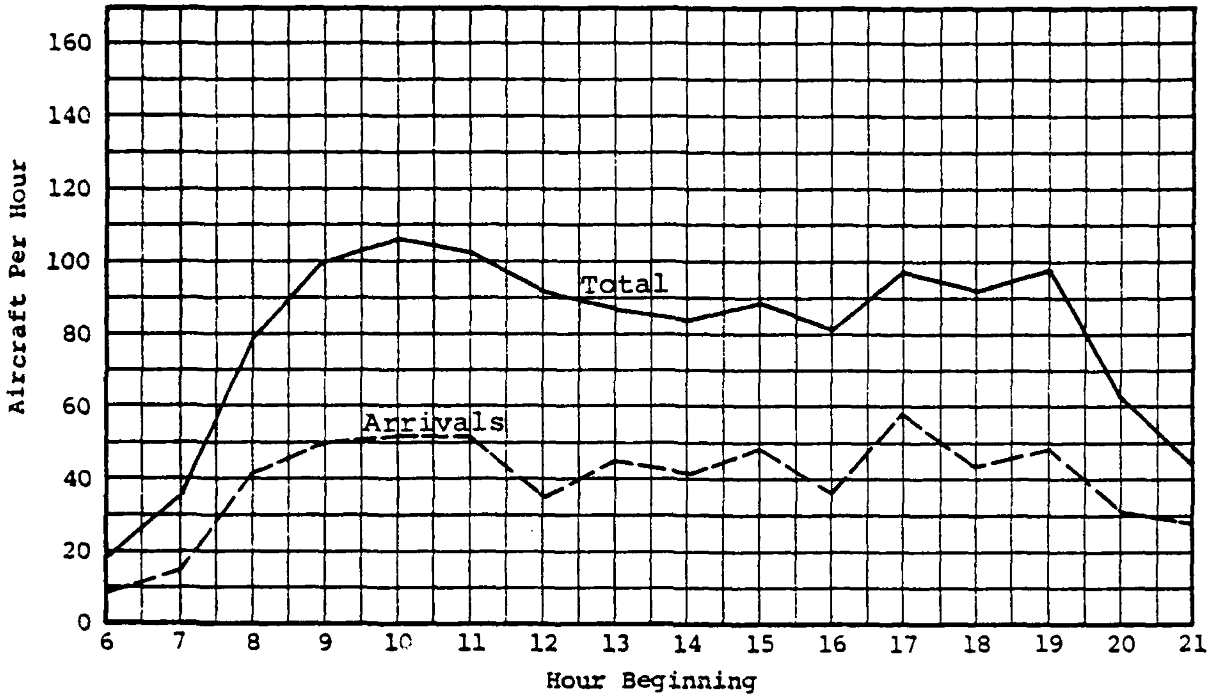
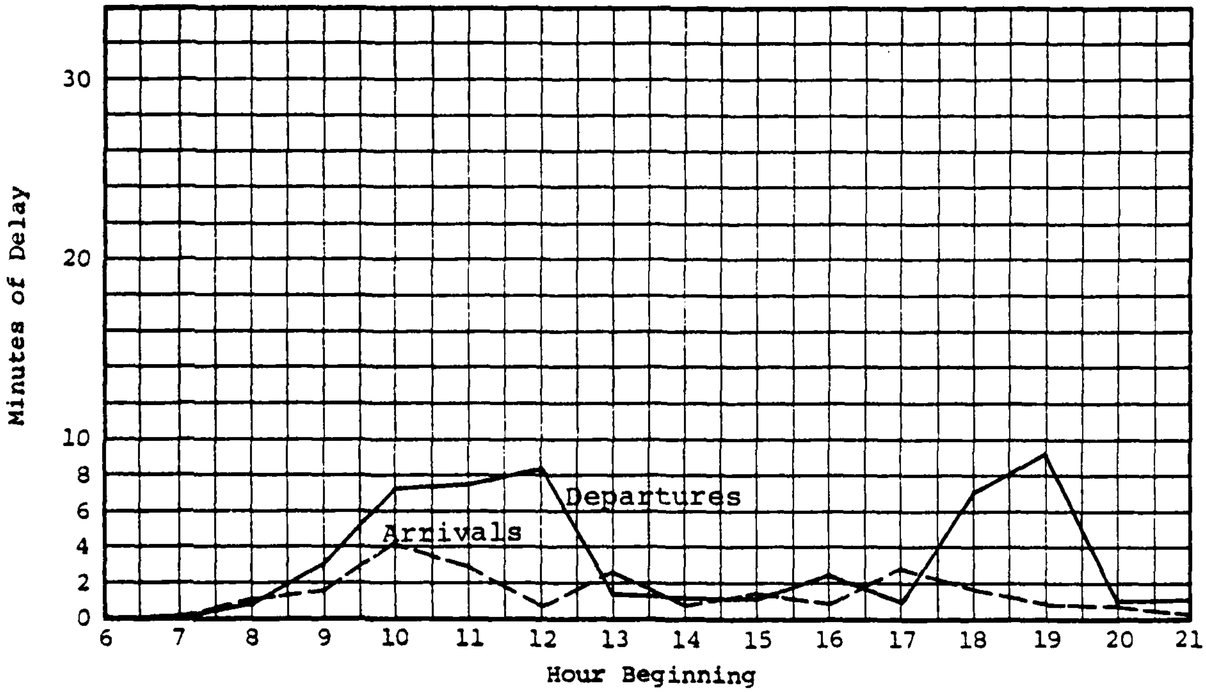


FIGURE 71B AVERAGE RUNWAY DELAYS



Experiment No. 72

Objective:

To estimate the delay impact of arrivals of Runway 25 interacting with arrivals on Runway 26R.

Arrival Runways	Departure Runways
25, 26L, 26R	35L, 35R

Related Comparison Experiments:

Experiment 9 is the 1985 baseline for comparison.

Results:

Figure 72A shows that total aircraft flows vary from 28 to 116 aircraft per hour over the 16 hour simulation run. The peak hour is from 1000 to 1100 hours and contains 58 arrival aircraft and 58 departure aircraft.

Figure 72B shows that average delays to aircraft using the runways are as high as 4.1 minutes per aircraft. Peak hour average delays are 1.4 minutes for arrival aircraft and 3.9 minutes for departure aircraft.

Comparison of these flows and delays with the runway flows and delays for Experiment 9 shows that at 1985 demand levels dependency between aircraft on Runways 25 and 26L does not significantly impact arrival aircraft delays.

FIGURE 72A AVERAGE RUNWAY FLOW RATES

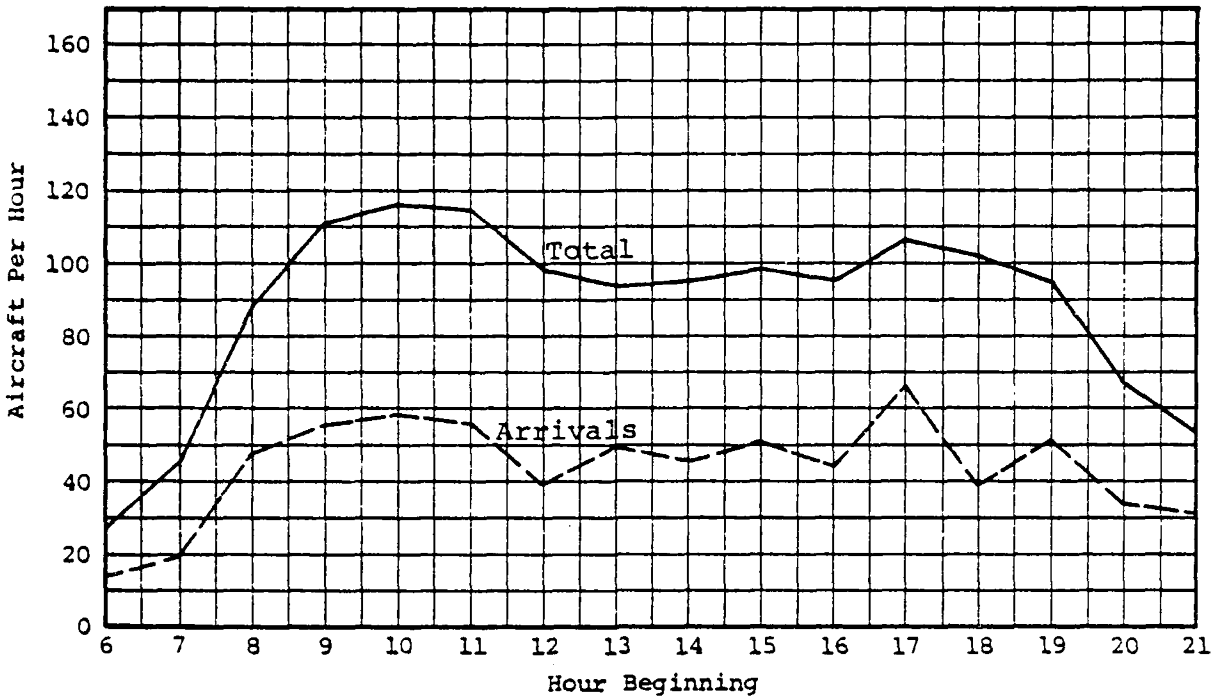
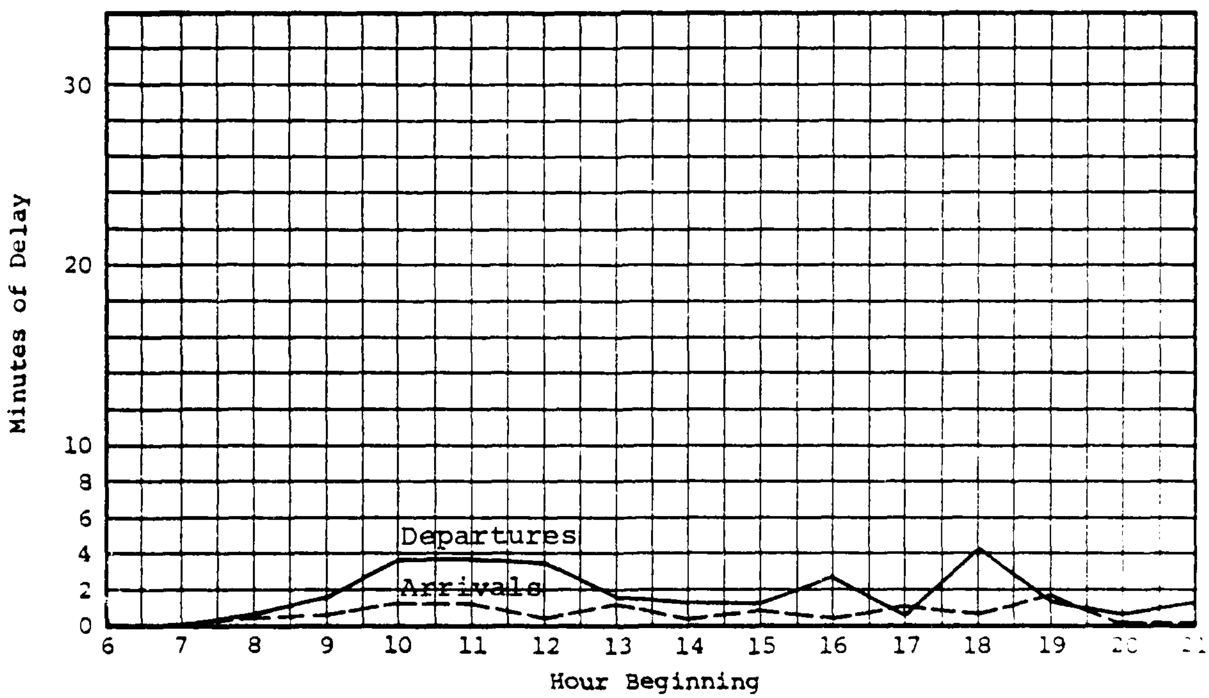


FIGURE 72B AVERAGE RUNWAY DELAYS



AD-A092 456 PEAT MARWICK MITCHELL AND CO SAN FRANCISCO CALIF F/G 1/5
TASK FORCE DELAY STUDY. DENVER STAPLETON INTERNATIONAL AIRPORT,--ETC(U)
MAR 80 DOT-FA77WA-3961

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Attachment B

DELAY SUMMARY: STAGE 1 & STAGE 2
AIRFIELD SIMULATION MODEL EXPERIMENTS

STAPLETON INTERNATIONAL AIRPORT

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.

November 1978

DELAY SUMMARY
STAGE 1 & 2 AIRFIELD SIMULATION MODEL EXPERIMENTS

Expt. No.	Page No.	Weather	Demand	ATC Scenario	Experiment Description	Runway Delay (minutes) ARRIVALS Max. Average	ARRIVALS Average Daily[a]	DEPARTURES Max. Average	DEPARTURES Average Daily[a]
2	b	VFR1	1978	1978	Baseline	4.0	1.3	4.7	2.1
5	2				Closure of Runway 7-25	9.4	4.0	4.7	2.3
8	b				Metering rate = 60/hr.	5.3	2.3	4.2	1.7
4	b	VFR1	1985	1978	Baseline	3.3	1.7	2.8	0.9
29	b				Extend Runway 26R	3.2	1.4	1.9	0.5
30	b				Extend Taxiway D-1	3.4	1.5	1.9	0.6
9	b	VFR1	1985	1985	Baseline	1.8	0.7	4.2	2.0
13	b				Reduce general aviation demand 50%	1.8	0.8	4.3	1.8
72	33				Runway 25 arrivals dependent	1.9	0.7	4.1	2.1
10	b	IFR1	1985	1985	Baseline	c	c	9.3	4.0
11	b				Reduce air carrier demand 10%	c	c	4.7	1.9
71	31				Two IFR independent arrival streams	4.2	1.7	9.3	4.0
15	b	IFR2	1985	1985	Baseline	c	c	c	c
31	b				ASDE	c	c	c	c
35	4				Simultaneous ILS approaches	3.6	1.1	15.4	5.7
65	21				New 5,000-ft. N-S runway	c	c	c	c
18	b	VFR1	1985	1985	Baseline	7.8	2.6	25.5	10.9
					High speed exit-Runway 17L	7.6	2.5	22.5	9.7
36	6	VFR1	1990	1990	Baseline	0.8	0.4	3.7	1.6
39	10				Increase air carrier demand 25%	1.7	0.7	4.0	2.4
62	17				1978 general aviation demand	1.0	0.5	3.7	1.8
67	23				Vortex hazard present	0.9	0.4	5.0	2.8
37	8	IFR1	1990	1990	Baseline	c	c	6.1	2.2
41	12				Reduce air carrier demand 10%	30[d]	18.6	1.0	0.2
68	25	IFR/ VFR1	1985	1985	Baseline	45-60[e]	22.1	7.0	2.7
64	19				Reduce general aviation demand 50%	30-45[f]	13.5	4.6	2.1
70	29	IFR1/ VFR1	1985	1985	Baseline	12.0	2.4	7.2	1.8
69	27				Extend Runway 26R	12.9	2.6	4.9	1.2

a. 16-hour day 0600 to 2200 hours.
b. See Data Package No. 4.
c. Delays in excess of one hour due to extended periods of time when demand exceeds capacity.
d. Average delay per aircraft is some 30 minutes over a 3-hour period.
e. Average delay per aircraft is some 45 to 60 minutes over a 4-hour period.
f. Average delay per aircraft is some 30 to 45 minutes over a 4-hour period.

Attachment C

PMM&CO. DELAY STUDY REPORT OUTLINE

STAPLETON INTERNATIONAL AIRPORT

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.

November 1978

PMM&Co. Delay Study Report Outline

Executive Summary

Relationship to other Reports

Summary of Results

Background

History and Objectives of Task Force

Capacity Analysis and Interim Report

Delay Study Steps and Meetings

Model Calibration

Data Collection and Reduction

Model Runs and Comparisons

Experimental Design

Stage 1 and 2 experiments

Delay Results

Results for each experiment

Conclusions from experiments

Appendices

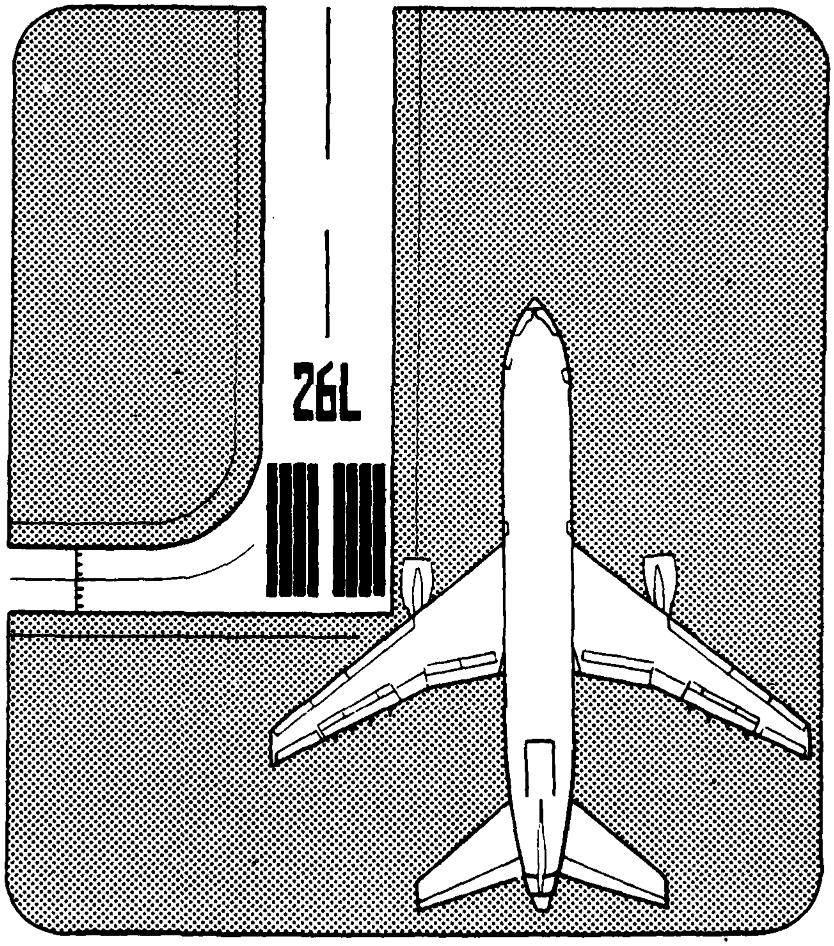
Definition of terms

List of Data Packages

STAPLETON INTERNATIONAL AIRPORT

DATA PACKAGE NO. 7

AIRPORT IMPROVEMENT TASK FORCE DELAY STUDIES



prepared for

DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

under contract

DOT FA77WA -3961

PMM&Co. Peat, Marwick, Mitchell & Co.

DECEMBER 1978

PEAT, MARWICK, MITCHELL & CO.
P. O. BOX 8007
SAN FRANCISCO INTERNATIONAL AIRPORT
SAN FRANCISCO, CALIFORNIA 94128

Telephone: (415) 347-9521

December 8, 1978

Mr. Ray Fowler, AEM-100
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

Re: Data Package No. 7 for Stapleton Delay Experiments

Dear Ray:

Enclosed is Data Package No. 7 for Stapleton International Airport. The package contains the results of Experiment 36a, revised results for Experiments 65 and 69 (Attachment A), and the input data for some experiments previously run (Attachment B).

This data package should be reviewed by the Stapleton Task Force during the December 11, 1978, Task Force meeting.

Sincerely,

Stavey

S. L. M. Hockaday
Manager

SLMH/sh

cc: Mr. J. R. Dupree (ALG-312)
Mr. F. Jaeger (ARM-4)

Attachment A

STAGE 2 DELAY EXPERIMENTS: REVISED AND ADDITIONAL RESULTS

STAPLETON INTERNATIONAL AIRPORT

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.

December 1978

Experiment No. 36a

Objective:

To estimate the delay impact of closing Runway 7-25 in VFR1 weather:

Arrival Runways	Departure Runways
26L, 26R	35L, 35R

Related Comparison Experiments:

Experiment 36 is the 1990 baseline for comparison.

Results:

Figure (36A)A shows that total aircraft flows vary from 12 to 131 aircraft per hour over the 16 hour simulation run. The peak hour is from 1000 to 1100 hours and contains 66 arrival aircraft and 65 departure aircraft.

Figure (36A)B shows that average delays to aircraft using the runways are as high as 3.8 minutes per aircraft. Peak hour average delays are 3.7 minutes for arrival aircraft and 3.8 minutes for departure aircraft.

Comparing these flows and delays with experiment 36 shows that closure of Runway 7-25 causes delays to arrival aircraft to increase by some 3 minutes in the peak hour.

FIGURE (36A)A AVERAGE RUNWAY FLOW RATES

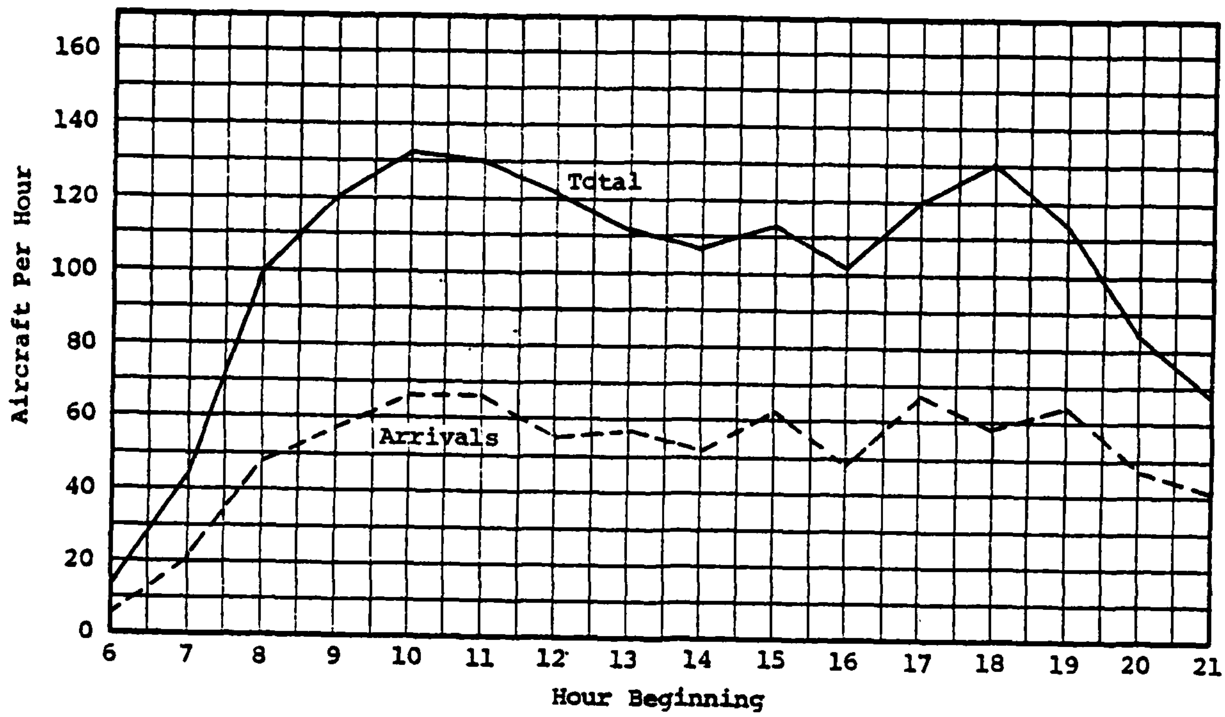
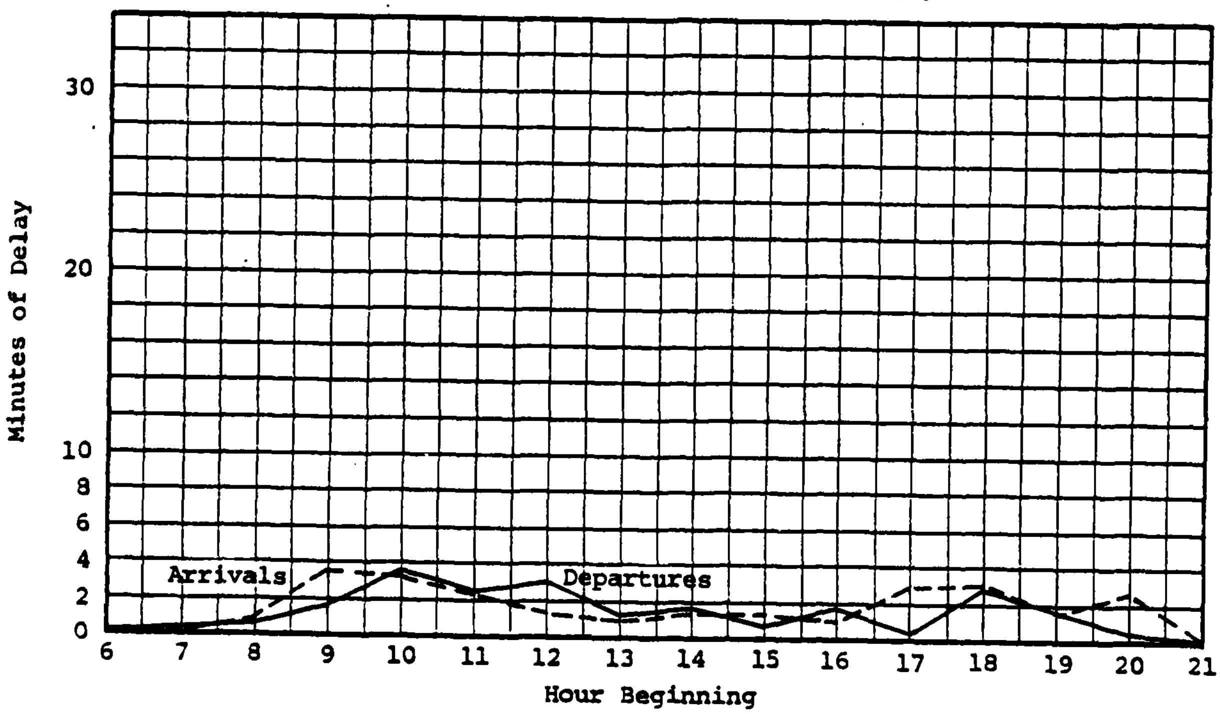


FIGURE (36A)B AVERAGE RUNWAY DELAYS



Experiment No. 65

Objective:

To estimate the delay impact of a new 5,000-foot N-S runway (Runway 34) in IFR2 conditions.

Arrival Runways	Departure Runways
34, 35R	34, 35L

Related Comparison Experiments:

Experiment 15 is the 1985 baseline for comparison.

Results:

Figure 65A shows that total aircraft flows vary from 5 to 82 aircraft per hour over the 16 hour simulation run. The peak hour is from 1000 to 1100 hours and contains 42 arrival aircraft and 40 departure aircraft.

Figure 65B shows that average delays to aircraft using the runways are as high as some 75 minutes per aircraft. Peak hour average delays are some 5.7 minutes for arrival aircraft and 20.1 minutes for departure aircraft.

The high delays are due to an excess of demand over capacity.

Comparison of these flows and delays with the runway flows and delays for Experiment 15 shows that a new 5,000-foot N-S runway will significantly reduce aircraft delays in IFR2 conditions.

FIGURE 65A AVERAGE RUNWAY FLOW RATES

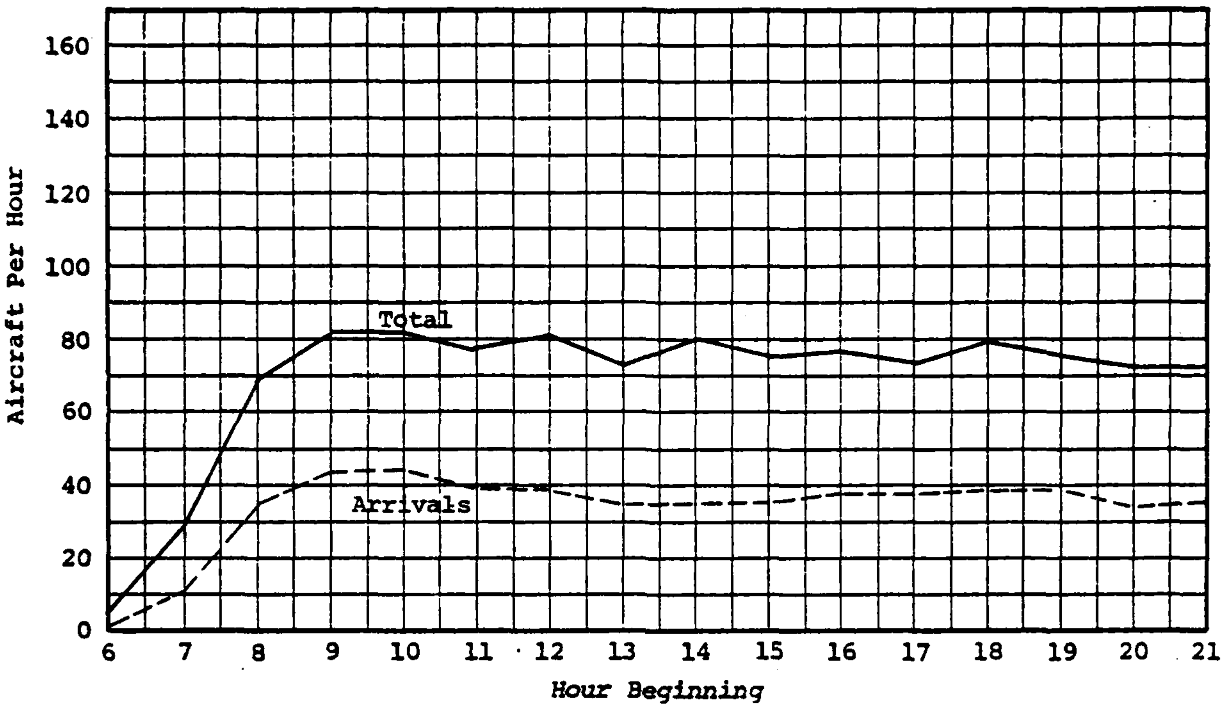
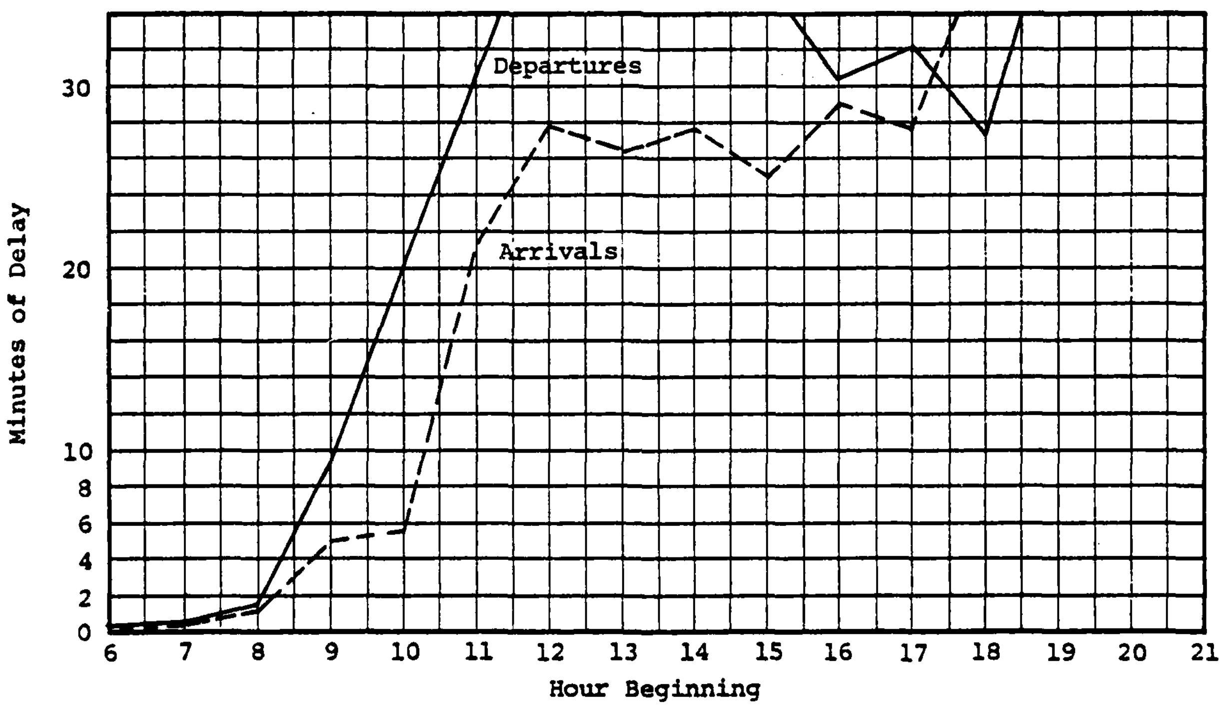


FIGURE 65B AVERAGE RUNWAY DELAYS



Experiment No. 69

Objective:

To estimate the delay impact of extending Runway 26R east to equal the length of Runway 26L.

	Arrival Runways	Departure Runways
IFR1:	8L, 17L	8R
VFR1:	8L, 17L, 17R	7, 8R

Related Comparison Experiments:

Experiment 70 is the 1985 baseline for comparison.

Results:

Figure 69A shows that total aircraft flows vary from 18 to 111 aircraft per hour over the 16 hour simulation run. The peak hour is from 1200 to 1300 hours and contains 51 arrival aircraft and 60 departure aircraft.

Figure 69B shows that average delays to aircraft using the runways are as high as 12 minutes per aircraft. Peak hour average delays are 0.6 minute for arrival aircraft and 0.3 minute for departure aircraft.

Comparison of these flows and delays with the runway flows and delays for Experiment 70 shows that extending Runway 26R reduces departure delays by as much as 1.7 minutes per aircraft in some periods of the day.

FIGURE 69A AVERAGE RUNWAY FLOW RATES

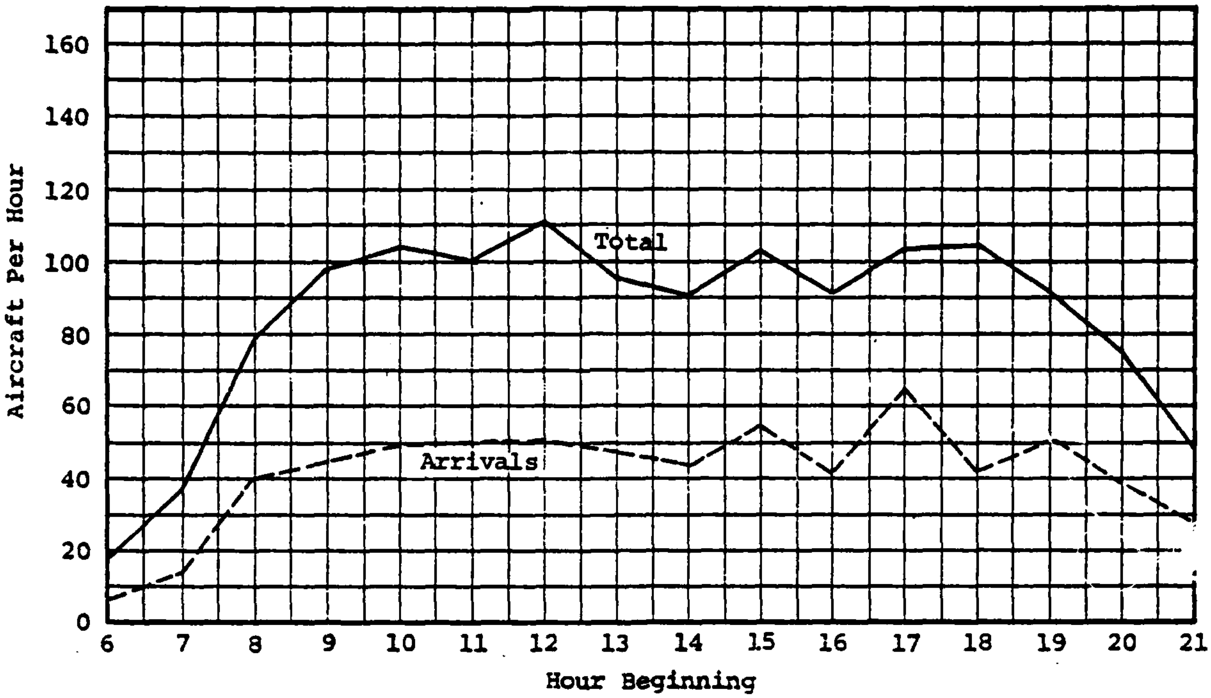
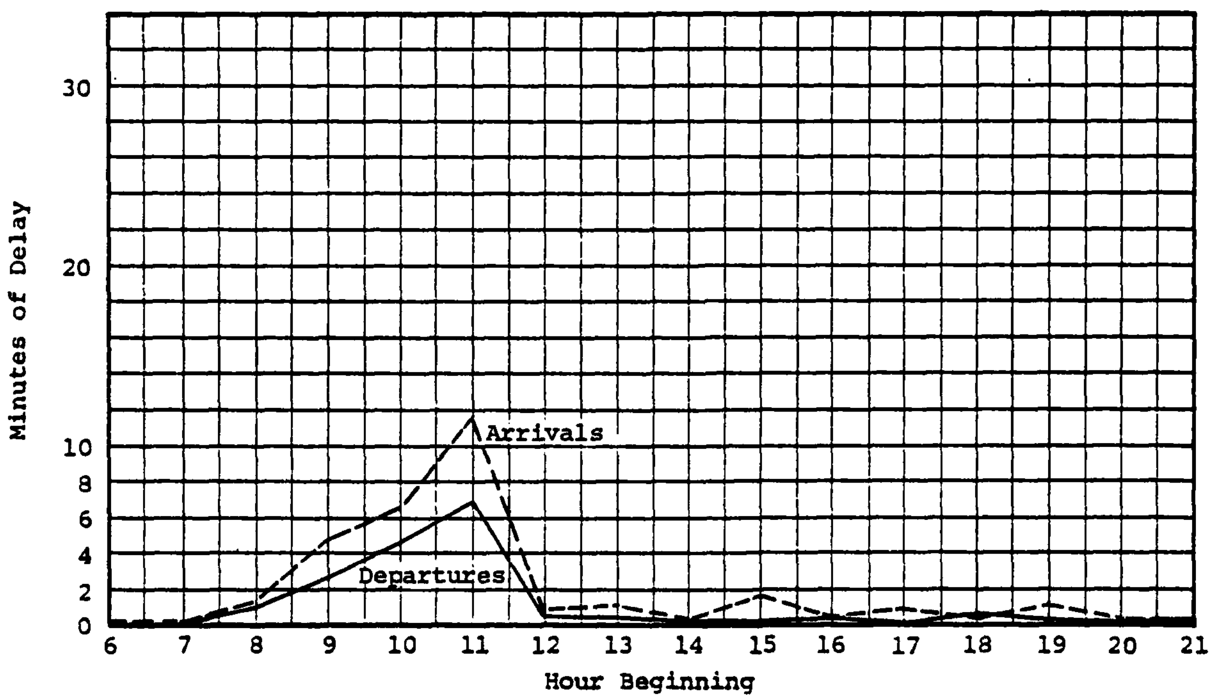


FIGURE 69B AVERAGE RUNWAY DELAYS



Attachment B

STAGE 2 DELAY EXPERIMENTS: ADDITIONAL INPUT DATA

STAPLETON INTERNATIONAL AIRPORT

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.

December 1978

Stage 2 Delay Experiments

Attached are additional input data for Experiments 51 through 58 and 67 through 72. These data were not included in prior packages.

Inputs for Annual Delay
Model Experiments

Experiment Number	Input Changes from Experiment Number	Description of Input Changes
54	50	1985 Demand
52	54	1985 ATC
53	54	1985 Near-Term Improvements
51	53	1985 ATC
58	50	1990 Demand
56	58	1990 ATC
57	58	1990 Near-Term Improvements
55	57	1990 ATC

Capacity Inputs to Annual Delay Model:
1978 Baseline

Runway Use	Weather	Hourly Runway Capacity (50% Arrivals)
1	VFR1	165
	VFR2	135
	IFR1	63
	IFR2	63
2	IFR2	59
3	VFR1	125
	VFR2	117
	IFR1	63
	IFR2	60
4	VFR1	109
5	VFR1	130
	IFR1	63
6	VFR1	86
7	VFR1	115

Experiment Number: 67 (Input changes from experiment number 36)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway and links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	Change separations to reflect vortex hazards
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	

Experiment Number: 68 (Input changes from experiment number 10)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	Implement for IFR to VFR change at 12:00 noon
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	Add VFR separations after 12:00 noon
19 Route data	
20 Two-way path data	
21 Common approach paths	Change to VFR paths after 12:00 noon
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	Change to VFR paths after 12:00 noon
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	

Experiment Number: 69 (Input changes from experiment number 70)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Revise runway utilization

Experiment Number: 70 (Input changes from experiment number 68)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway end links	Revise to reflect proper runways
13 Runway crossing links	Revise to reflect proper runways
14 Exit taxiway location	Revise to reflect proper runways
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	Revise to reflect proper runways
29 Arrival runway occupancy times	Revise to reflect proper runways
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Reassign runways

Experiment Number: 71 (Input changes from experiment number 10)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	Revise to reflect independent arrival streams
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Revise runway utilization

Experiment Number: 72 (Input changes from experiment number 9)

SIMULATION MODEL INPUT	DESCRIPTION OF INPUT CHANGE
a. Logistics	
1 Title	
2 Random number seeds	
3 Start and finish times	
4 Print options	
5 Airline names	
6 Processing options	
7 Truncation limits	
8 Time switch	
b. Airfield Physical Characteristics	
9 Airfield network	
10 Number of runways	
11 Runway identification	
12 Departure runway end links	
13 Runway crossing links	
14 Exit taxiway location	
15 Holding areas	
16 Airline gates	
17 General aviation basing areas	
c. ATC Procedures	
18 Aircraft separations	Revise to reflect dependency between 25 and 26R arrivals
19 Route data	
20 Two-way path data	
21 Common approach paths	
22 Vectoring delays	
23 Departure runway queue control	
24 Gate hold control	
25 Departure airspace constraints	
26 Departure queue	
27 Runway crossing delay control	
d. Aircraft Operational Characteristics	
28 Exit taxiway utilization	
29 Arrival runway occupancy times	
30 Touch-and-go runway occupancy times	
31 Departure runway occupancy times	
32 Taxi speeds	
33 Approach speeds	
34 Gate service times	
35 Airspace travel times	
36 Runway crossing times	
37 Lateness distribution	
38 Demand	Reduce general aviation demand 50%

Telephone: (415) 347-9521

December 22, 1978

Mr. Ray Fowler, AEM-100
Federal Aviation Administration
800 Independence Avenue
Washington, D.C. 20591

Re: Delays to Aircraft at Denver with 2-1/2 Mile Separations

Dear Ray:

In response to your request, PMM&Co. has conducted two additional annual delay model experiments No. 55A and 56A for Stapleton International Airport. The experiments were performed with 1990 demand, with intermediate term separations defined in FAA-EM-78-78A, and with and without the Denver 1990 airfield improvement package.

The results are given in the following tabulation which also presents results from other experiments for comparison.

Experiment No.	ATC Scenario	Airfield Improvements	Average Aircraft Delay (Minutes)
58	Today (3)	None	4.8
56A	Intermediate (2-1/2)	None	2.5
56	Far (2)	None	1.2
57	Today (3)	1990	0.8
55A	Intermediate (2-1/2)	1990	0.5
55	Far (2)	1990	0.4

Please let me know if you have any comments on these experiments and also if you would like these results incorporated into the Denver final report.

Sincerely,

Stephen L. M. Hockaday
Manager

SLMH/sq

cc: Mr. J. R. Dupree, ALG-312
Mr. A. Haines (MITRE)

bcc: D. Maddison
H. Fan
S. L. M. Hockaday

Telephone: (415) 347-9521

March 1, 1979

Mr. Mike Scott (ATF-4)
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

Subject: Revised Baseline Values

Dear Mike:

Enclosed are revised values of baseline (1978) annual delay requested by the Stapleton Task Force. These values reflect Task Force concerns on (i) arrival operations on Runway 25; (ii) departure constraints due to airspace conflicts; and (iii) delays due to metering rates and runway use changes. The output also provides information on arrival and departure delays in addition to average delays.

These revised values respond to Task Force concerns about the annual delay values. PMM&Co. plans to meet with members of the Stapleton Task Force on March 8, 1979, to review these values. If you have any questions or comments, please let us know.

Sincerely,

Henry Fan
Senior Consultant

HF/nlm
Enclosure

cc: Mr. J. Dupree, ALG-312 (w/o encl)
Mr. F. Jaeger, FAA-RM Region (w/encl)
Mr. K. Mountjoy, UAL (w/encl)

bcc: TF Proj Den (w/encl)
S. L. M. Hockaday (w/encl)

(Addressee w/o encl)

SUMMARY OF BASELINE ANNUAL DELAY EXPERIMENT

Annual Demand:	512,500
Annual Delay:	24,243 hours
Average Aircraft Delay:	2.8 minutes

Average peak-hour delays for arrivals on 25, 26L, 26R, and departures on 35L, 35R:

	Average Peak-Hour Delays (minutes)[a]					
	VFR			IFR		
	Arrivals	Departures	Average	Arrivals	Departures	Average
Average Day, Peak Month	3.2	0.4	2.1	60+	60+	60+
Peak Day, Peak Month	3.5	0.4	2.3	60+	60+	60+
Low Day, Low Month	1.9	0.3	1.2	42.8	24.3	33.8

a. Note that delays are averages for both commercial and general aviation aircraft. Therefore, air carrier average delays can be expected to be higher. For example, peak-hour air carrier arrival delays for an average day peak month may be close to 5 mintues compared to an average of 3.2 minutes for all arrival operations.

Telephone: (415) 347-9521

March 12, 1979

Mr. Mike Scott (ATF-4)
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

Subject: Baseline Runway Capacities for Denver Stapleton International Airport

Dear Mike:

In response to a request of the Stapleton Task Force during our meeting on March 9, 1979, enclosed are baseline (1978) runway capacity values. We will be preparing runway capacities and annual delay values for the remaining nine (9) annual delay experiments in the near future. We are currently planning to present the results to the Stapleton Task Force in their April 12, 1979 meeting. If you have any questions or comments, please let us know.

Sincerely,

Henry Fan
Senior Consultant

HF/nbe
Enclosure

cc: Mr. J. Dupree, ALG-312 (w/o encl.)
Mr. F. Jaeger, FAA-RM Region (w/encl.)
Mr. K. Mountjoy, UAL (w/encl.)

bcc: TFD Proj. Den (w/encl.)
S. L. M. Hockaday (w/encl.)

(addressee without enclosure)

Baseline (1978) Runway Capacities
Denver Stapleton International Airport

Runway Use	Arrivals	Departures	Hourly Runway Capacity at 50% Arrivals			
			VFR1	VFR2	IFR1	IFR2
1	25, 26L/R	35L/R	150	135	63	63
2	35R	35L	95	95	63	59
3	17L/R	7, 8L/R	125	117	63	60
4	25, 26L/R	26 L/R	102	-[a]	-	-
5	8L/R	35L/R	130	121	63	63
6	17L/R	17L/R	90	-	-	-
7	8L/R	7, 8L/R	-	116	-	-

a. Configuration rarely used under this weather condition, capacity not computed.

Telephone: (415) 347-9521

February 2, 1978

Mr. Philip LaRochelle, AEM-100
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

Re: Preliminary Delay Analysis for
Stapleton International Airport

Dear Phil:

Attached are the results of our preliminary delay analysis to assess the impact of the closure, during part of 1978, of Runway 8R-26L at Stapleton International Airport.

It should be pointed out to all concerned that these results are both preliminary because they have not been reviewed or accepted by the Stapleton Task Force, and approximate, because they are derived from simplified "Handbook type" analysis techniques and not from airfield simulation model runs.

Sincerely yours,

Stephen L. M. Hockaday
Manager

SLMH/jc
Enclosures

cc: Mr. F. Jaeger (ARM-4)
Mr. J. R. Dupree (ALG-312)

Attachment

Preliminary Delay Analysis for
Stapleton International Airport

The preliminary analysis developed approximate estimates of increases in daily and peak-hour delays to aircraft due to the closure of Runway 8R-26L. Delay increases were developed for VFR 1 weather conditions, for three different demand levels:

- o Average daily traffic August 1977*
- o Average daily traffic April-November 1977 (which corresponds to a 14% decrease)
- o Average daily traffic in August 1977 plus 10%

Delays were developed for three different runway uses that include closure of Runway 8R-26L:

Runway Use	Arrivals	Departures
A**	25, 26R	35L, 35R
B	17L, 17R	17L, 17R
C	8L, 17L, 17R	7, 8L, 17L, 17R

Delays were also developed for a baseline case that includes operations on Runway 8R-26L (arrivals on 25, 26L, and 26R, and departures on 35L and 35R). The delay increases shown in Table 1 were developed by subtracting baseline delays from the delays computed for the three runway uses A, B, and C, with Runway 8R-26L closure.

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*Thirteen hours 8:00 a.m. through 9:00 p.m.
**During arrival peak periods, Runways 17L and 17R are also used for arrivals with no departure operations on Runways 35L and 35R.

Table 1

Delay Increases due to closure of Runway 8R-26L

Runway Use	Delay Increase (minutes/aircraft)					
	August 1977 Demand less 14%		August 1977 Demand		August 1977 Demand plus 10%	
	Peak Hour	Daily	Peak Hour	Daily	Peak Hour	Daily
A	4.5	2.6	17.3	11.9	46.0	43.1
B	44.5	40.6	106.8	93.8	127.6	120.1
C	1.2	0.7	1.7	1.2	2.3	1.6